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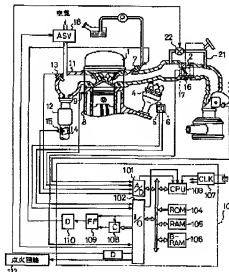
(54) EXHAUST EMISSION CONTROL DEVICE OF  
INTERNAL COMBUSTION ENGINE

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## (57) Abstract:

**PURPOSE:** To operate the catalyst warming up operation adequately regardless of the deteriorating condition of a catalyst.

**CONSTITUTION:** A control circuit 10 to control the warming up operation of a catalyst 12 is provided, and it decides whether the catalyst is activated or not depending on the output of an  $O_2$  sensor 13 provided at the upstream side of the catalyst, and the output of an  $O_2$  sensor 15 provided at the downstream side. When catalyst is not activated, the ignition timing lag angle of an engine 1, and the opening of an idle speed control valve (ISC valve) 22 are increased so as to raise the temperature of the catalyst 12. Since the catalyst warming up operation is carried out by detecting directly the activating condition of the catalyst, a useless warming up operation of the catalyst is prevented, as well as the catalyst is activated securely in a short time.



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CLAIMS

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[Claim(s)]

[Claim 1] An exhaust emission control device of an internal-combustion engine characterized by comprising the following.

A three way component catalyst provided in a flueway of an internal-combustion engine.

An upstream air fuel ratio sensor which is formed in an upstream flueway of this three way component catalyst, and detects an exhaust air fuel ratio of the three way component catalyst upstream.

A downstream air fuel ratio sensor which is formed in a downstream flueway of said three way component catalyst, and detects an exhaust air fuel ratio of the three way component catalyst downstream.

An air-fuel ratio control means which controls an air-fuel ratio of said organization based on said upstream air-fuel ratio sensor output at least, A catalyst non-active-state detection means to detect that said three way component catalyst is in a non-active state based on said upstream air-fuel ratio sensor output and said downstream air-fuel ratio sensor output, A catalytic activation means to perform operation of controlling said three way component catalyst temperature-up means, and raising temperature of said three way component catalyst when it is detected a catalyst temperature-up means to raise temperature of said three way component catalyst, and said three way component catalyst being in a non-active state.

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[Translation done.]

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the exhaust emission control device which can perform suitable catalyst warming-up operation according to the grade of degradation of a three way component catalyst in detail about the exhaust emission control device of an internal-combustion engine.

[0002]

[Description of the Prior Art] The exhaust emission control device of the internal-combustion engine which has arranged the catalytic converter which used for the flueway of the internal-combustion engine simultaneously the three way component catalyst which can be purified for HC under exhaust air, CO, and three detrimental constituents of  $\text{NO}_x$  is used more widely than before. Generally, unless the three way component catalyst used for the above exhaust emission control devices becomes the temperature beyond a certain temperature (activation temperature), it does not demonstrate exhaust-air-purification capability. For this reason, warming-up operation of what is called a catalyst of raising the temperature of the exhaust air which passes a catalyst by carrying out the angle of delay of the organization ignition timing, for example or other means, and making catalyst temperature reaching activation temperature at an early stage is performed at the time of start up between the organization colds, etc.

[0003] On the other hand, the activation temperature of a catalyst always is not constant, and with a new catalyst, in order for active temperature to show the tendency to go up as activation temperature is comparatively low and degradation of a catalyst progresses, it is necessary to perform warming-up operation of the above-mentioned catalyst according to the deterioration degree of a catalyst. For example, to JP, 60-153473, A. Catalyst temperature is detected, and when this catalyst temperature is below the prescribed temperature defined beforehand, while carrying out the angle of delay of the organization ignition timing and performing catalyst warming-up operation, the exhaust emission control device of the internal-combustion engine it was made to raise the above-mentioned prescribed temperature along with the increase in the cumulative operating time of an organization is indicated.

[0004] Since it is thought that the deterioration degree of a catalyst advances as a hour of use, i.e., the cumulative operating time of an organization, increases, the activation temperature of a catalyst is also considered to become high as organization cumulative operating time increases. It sets up beforehand become high in the device of the above-mentioned gazette, as organization cumulative operating time increases said prescribed temperature, When the actually detected catalyst temperature is below the above-

mentioned prescribed temperature, catalyst warming up by the ignition-timing angle of delay is performed as what the catalyst is not activating and catalyst temperature becomes more than the above-mentioned prescribed temperature, it is made to suspend catalyst warming up as what the catalyst activated.

[0005]

[Problem(s) to be Solved by the Invention]However, judgment whether catalyst temperature reached the prescribed temperature determined based on the cumulative operating time of an organization like the device of above-mentioned JP,60-153473,A and whether the catalyst was activated with the chisel may produce a problem actually. That is, since the activation temperature of a catalyst is not determined by only the hour of use and changes the degradation state of a catalyst with the condition of use of an organization, or dispersion for every product, even if it is the same hour of use (cumulative operating time), the activation temperature of a catalyst may not necessarily be in agreement. For this reason, if the existence of the activity of a catalyst is judged [ whether catalyst temperature reached prescribed temperature and ] with the chisel like the device of the above-mentioned gazette, In spite of fully not activating the catalyst actually, catalyst warming-up operation will stop, and activation of a catalyst is overdue, and exhaust property gets worse, or, Since the catalyst warming-up operation by the ignition-timing angle of delay is continued in spite of fully activating the catalyst actually, problems, such as a fall of an engine output and fuel consumption increase, arise.

[0006]In order to solve this problem, it is necessary to detect the existence of activation of a catalyst indirectly using catalyst temperature etc., but to detect the existence of activation of a catalyst directly, and to control warming-up operation of a catalyst based on this detection result. An object of this invention is to provide the exhaust emission control device of the internal-combustion engine which direct detection of the existence of activation of a catalyst is carried out, and can perform catalyst warming-up operation in view of the above.

[0007]

[Means for Solving the Problem]An upstream air fuel ratio sensor which according to this invention is formed in an upstream flueway of a three way component catalyst provided in a flueway of an internal-combustion engine, and this three way component catalyst, and detects an exhaust air fuel ratio of the three way component catalyst upstream, A downstream air fuel ratio sensor which is formed in a downstream flueway of said three way component catalyst, and detects an exhaust air fuel ratio of the three way component catalyst downstream, An air-fuel ratio control means which controls an air-fuel ratio of said organization based on said upstream air-fuel ratio sensor output at least, A catalyst non-active-state detection means to detect that said three way component catalyst is in a non-active state based on said upstream air-fuel ratio sensor output and said downstream air-fuel ratio sensor output, When it is detected a catalyst temperature-up means to raise temperature of said three way component catalyst, and that said three way component catalyst is in a non-active state, an exhaust emission control device of an internal-combustion engine provided with a catalytic activation means to perform operation of controlling said three way component catalyst temperature-up means, and raising temperature of said three way component catalyst is provided.

[0008]

[Function]It detects that a catalyst non-active-state detection means has a three way component catalyst in a non-active state based on an upstream air-fuel ratio sensor output and a downstream air-fuel ratio sensor output, and a catalytic activation means warms up a catalyst, only when it is detected by a catalyst non-

active-state detection means that a catalyst is in a non-active state. For this reason, when the catalyst is not actually being activated irrespective of catalyst temperature, warming-up operation is performed, and since warming-up operation is suspended when a catalyst is actually activated, suitable warming-up operation is performed according to the deterioration degree of a catalyst.

[0009]

[Example] Hereafter, the example of this invention is described using an accompanying drawing. Drawing 1 is the whole internal-combustion engine schematic diagram which applied the exhaust emission control device of this invention. In drawing 1, the air flow meter with which provide 1 in an internal combustion engine body, 2 was provided in the suction passage, and 3 was provided in the suction passage is shown. Direct measuring of the suction air quantity is carried out, the movable vane type air flow meter etc. which contained the potentiometer are used, and the air flow meter 3 generates the output signal of the analog voltage proportional to suction air quantity. This output signal is inputted into A/D converter 101 with a built-in multiplexer of the control circuit 10. The crank angle sensor 5 which converts into a crank angle and generates the pulse signal for reference position detection every 720 degrees, and the crank angle sensor 6 which converts into a crank angle and generates the pulse signal for crank angle detection every 30 degrees are formed for the axis in the distributor 4, respectively. The pulse signal of these crank angle sensors 5 and 6 is supplied to the input/output interface 102 of the control circuit 10, among these the output of the crank angle sensor 6 is supplied to the interruption terminal of CPU103.

[0010] The fuel injection valve 7 for supplying application-of-pressure fuel to an inlet port from a fuel supply system for every cylinder is formed in the suction passage 2. The idle switch 17 which generates the signal which shows whether the throttle valve 16 is in a full-close state, i.e., LL signal, is formed in the throttle valve 16 of the suction passage 2. This idle status-out-put signal LL is supplied to the input/output interface 102 of the control circuit 10.

[0011] In this example, the bypass channel 21 which bypasses the throttle valve 16, and the idle speed control valve (ISC valve) 22 which controls the air content which flows through this bypass channel 21 are formed in the suction passage 2. It is used for ISC valve 22 being a flow control valve driven with the actuator of proper forms, such as a stepper motor, operating with the output signal from the control circuit 10, adjusting the engine intake air quantity at the time of an idle, and controlling the idle rpm of an organization to target revolving speed.

[0012] In this example, ISC valve 22 functions by raising organization idle rpm also as a part of catalyst temperature-up means to increase the amount of exhaust streams and to raise catalyst temperature, when the catalyst is not being activated like the after-mentioned. The water temperature sensor 9 for detecting the temperature of cooling water is formed in the engine water jacket 8 of the cylinder block of the main part 1 of an organization. The water temperature sensor 9 generates the electrical signal of the analog voltage according to the temperature of cooling water. This output is also supplied to A/D converter 101.

[0013] The catalytic converter 12 which accommodates the three way component catalyst which purifies simultaneously the three detrimental constituents HC and CO and NO<sub>x</sub> in exhaust gas is formed in the downstream exhaust system from the exhaust manifold 11 of the organization 1. The upstream air fuel ratio sensor (this example O<sub>2</sub> sensor) 13 and the downstream air fuel ratio sensor (this example O<sub>2</sub> sensor) 15 are formed in the exhaust manifold 11 of the upstream of the catalytic converter 12, and the exhaust pipe 14

of the downstream of the catalytic converter 12, respectively.

[0014]The O<sub>2</sub> sensors 13 and 15 detect the oxygen component concentration in exhaust gas, and generate the output voltage from which an air-fuel ratio differs according to the Lean side and a rich side to theoretical air fuel ratio. The output voltage of the O<sub>2</sub> sensors 13 and 15 is supplied to A/D converter 101 of the control circuit 10. It is the secondary air introduction inlet valve which 18 showed to drawing 1, and is for supplying secondary air to the exhaust manifold 11 from air supplies, such as an air pump which is not illustrated at the time of a slowdown or an idol, etc., and reducing HC and CO emission.

[0015]The control circuit 10 is constituted, for example as a microcomputer, and ROM104, RAM105, backup RAM106, and clock generation circuit 107 grade other than A/D-converter 101, input/output interface 102, and CPU103 are provided. In this example, the control circuit 10 performs basic control, such as fuel injection control of the organization 1, and ignition timing control, and also. The function as each means indicated to claims 1, such as an air-fuel ratio control means which controls an engine air fuel ratio like the after-mentioned, a catalyst non-active-state detection means to detect whether the catalyst 12 is in an active state, and a catalytic activation means to control the angle of delay and ISC valve 22 of organization ignition timing, and to perform catalyst warming up, is achieved.

[0016]In the control circuit 10, it is for the down counter 108, the flip-flop 109, and the drive circuit 110 controlling the fuel injection valve 7. That is, in the below-mentioned routine, if the fuel oil consumption (injection time) TAU calculates, the injection time TAU will be preset by the down counter 108, and the flip-flop 109 will be set. As a result, the drive circuit 110 starts energization of the fuel injection valve 7. On the other hand, when the down counter 108 calculates a clock signal (not shown) and the output terminal is set to "1" level at the last, the flip-flop 109 is set and the drive circuit 110 stops energization of the fuel injection valve 7. That is, as for the fuel injection valve 7, only the above-mentioned fuel injection duration TAU will be energized, and the fuel of quantity according to the time TAU will be supplied to the combustion chamber of the organization 1.

[0017]The input/output interface 102 of the control circuit 10 is connected to the firing circuit 112. Ignition timing of the organization 1 is controlled.

That is, after inputting the reference crank angle pulse signal of the crank angle sensor 6 into the input/output interface 102, the control circuit 10 outputs an ignition signal to the firing circuit 112, whenever a crankshaft reaches predetermined angle of rotation, and it makes the spark plug (not shown) of each cylinder generate a spark. Ignition timing of the organization 1, the optimum value is stored in ROM104 of the control circuit 10 as a function of operating conditions, such as load (for example, suction air quantity per organization 1 rotation), and number of rotations.

The optimal ignition timing is determined according to an operating condition.

[0018]The intake air content data and cooling-water-temperature data of the air flow meter 3 are incorporated by the A/D conversion routine performed for every predetermined time or specified crank angle, and are stored in the predetermined region of RAM105. That is, the intake air content data and cooling-water-temperature data in RAM105 are updated for every predetermined time. rotational speed data -- 30-degreeCA (crank angle) of the crank angle sensor 6 -- each time -- it calculates by interruption and is stored in the predetermined region of RAM105.

[0019]In this example, the control circuit 10 performs the 1st Air Fuel Ratio Control that controls an engine air fuel ratio based on upstream  $O_2$  sensor 13 output, and the 2nd Air Fuel Ratio Control that amends this 1st Air Fuel Ratio Control based on downstream  $O_2$  sensor 15 output. Hereafter, this the 1st and 2nd Air Fuel Ratio Control that are performed by the control circuit 10 using drawing 6 from drawing 2 are explained.

[0020]Drawing 2 and drawing 3 show the 1st air-fuel ratio feedback control routine that calculates the air-fuel ratio correction factor FAF based on the output of the upstream  $O_2$  sensor 13. This routine is performed 4 ms of predetermined time, for example, every. In Step 201, it is distinguished whether the closed-loop (feedback) conditions of the air-fuel ratio by the upstream  $O_2$  sensor 13 are satisfied. When cooling water temperature is below a predetermined value (for example, 70 °C), for example, under organization start up, During the increase in quantity after start up, warming-up increase in quantity, and power increase in quantity, during the fuel-oil-consumption increase in quantity for catalyst overheat prevention, when the output signal of the upstream  $O_2$  sensor 13 is not once reversed, each fuel cut middle class has abortive closed-loop conditions, and the case of others is closed-loop condition formation. When closed-loop conditions are abortive, it progresses to drawing 3 and Step 225, and the air-fuel ratio feedback flag XMFB is set to "0", it progresses to Step 226, and a routine is ended. It is good also considering the air-fuel ratio correction factor FAF as 1.0. On the other hand, in closed-loop condition formation, it progresses to Step 202.

[0021]or [ that carry out the A/D conversion of the output VOM of the upstream  $O_2$  sensor 13, incorporate it in Step 202, and an air-fuel ratio is rich by whether VOM is below comparison voltage  $V_{R1}$  at Step 203 ] – it is distinguished whether you are Lean. Comparison voltage  $V_{R1}$  usually takes the voltage of the amplitude center of  $O_2$  sensor output, and is  $V_{R1}=0.45V$  in this example. Steps 204-209 and Steps 210-215 show the setting operation of FU air-fuel ratio flag F1 based on the value of upstream  $O_2$  sensor 13 output judged at Step 203.

[0022]Air-fuel ratio flag F1 is a flag with which the exhaust air fuel ratio of the catalyst 12 upstream shows Rich or Lean.

the value of flag F1 – countdown (at the time of a lean air fuel ratio) or count-up (at time of rich air fuel ratio) operation of the delay counter CDLY – a time delay (TDL) predetermined in upstream (Steps 206 and 212)  $O_2$  sensor 13 output More than TDR is changed into 1 (rich)-0 (Lean), or 0-1, when rich or it is held at Lean (Steps 207-209, Steps 213-215).

TDL (Steps 207 and 208) is the Lean time delay for holding judgment that it is a rich condition even if the output of the upstream  $O_2$  sensor 13 changes from Rich to Lean here, It defines as a negative value, and

TDR (Steps 213 and 214) is a rich time delay for holding judgment that it is in the Lean state, even if the output of the upstream  $O_2$  sensor 13 changes from Lean richly, and it is defined by the positive value.

[0023]Next, in Step 216, it is distinguished whether the air-fuel ratio whether the numerals of air-fuel ratio flag F1 were reversed and after delay processing was reversed. If the air-fuel ratio is reversed, the reversal to Lean from Rich and the reversal to Rich from Lean will be distinguished with the value of air-fuel ratio flag

F1 at Step 217. If it is reversal to Lean from Rich, the air-fuel ratio correction factor FAF will be increased in skip with  $FAF < FAF + RSR$  at Step 218, and an air-fuel ratio will be amended to a rich side. If it is reversal to Rich from Lean conversely, at Step 219,  $FAF < FAF - RSL$  and FAF will be decreased in skip, and an air-fuel ratio will be amended to the Lean side. That is, skip processing is performed.

[0024] If the numerals of air-fuel ratio flag F1 are not reversed at Step 216, integration treatment is performed at Step 220, 221, 222. That is, it distinguishes whether it is  $F1 = "1"$  at Step 220, if it is  $F1 = "0"$  (Lean), it will be considered as  $FAF < FAF + KIR$  at Step 221, and if it is another side and  $F1 = "1"$  (rich), it will be considered as  $FAF < FAF - KIL$  at Step 222. Here, the constant of integration KIRKIL is set up small enough as compared with the skip amount RSRSL, and is  $KIR(KIL) < RSR(RSL)$ . Therefore, Step 221 makes an air-fuel ratio shift to a rich side gradually in the state of Lean ( $F1 = "0"$ ), and Step 222 makes an air-fuel ratio shift to the Lean side gradually in a rich condition ( $F1 = "1"$ ).

[0025] Next, in Step 223, the air-fuel ratio correction factor FAF calculated at Step 218, 219, 221, 222 is guarded at the minimum, for example, 0.8, and is guarded at the maximum, for example, 1.2. When the air-fuel ratio correction factor FAF becomes large too much by a certain cause or it becomes small too much by this, it prevents controlling the air-fuel ratio of an organization by the value, and becoming the Oba richness and Oba Lean.

[0026] In Step 224, the air-fuel ratio feedback flag XMFB is set to "1", FAF calculated like \*\*\*\* is stored in RAM105, and this loop is ended at Step 226. Next, the case where this invention is applied to the double  $O_2$  sensor system which performs feed back control of air-fuel ratio using both output VOM of the upstream  $O_2$  sensor 13 and output VOS of the downstream  $O_2$  sensor 15 is explained.

[0027] Drawing 4 is drawing 2 and a timing diagram which explains supplementarily operation by the flow chart of drawing 3. If air-fuel ratio signal A/F of richness and the Lean distinction is obtained as output VOM of the upstream  $O_2$  sensor 13 shows to drawing 4 (A), as shown in drawing 4 (B), the delay counter CDLY will be counted up by a rich condition, and will be counted down in the state of Lean. As a result, as shown in drawing 4 (C), air-fuel ratio signal A/F' (equivalent to flag F1) by which delay processing was carried out is formed. For example, even if air-fuel ratio signal A/F' changes from Lean richly in time  $t_1$ , air-fuel ratio signal A/F' by which delay processing was carried out changes richly at time  $t_2$ , after only rich time delay TDR is held at Lean. Even if air-fuel ratio signal A/F changes from Rich to Lean in time  $t_3$ , air-fuel ratio signal A/F' by which delay processing was carried out changes to Lean in time  $t_4$ , after only an equivalent for the Lean time delay (-TDL) is held richly. However, if air-fuel ratio signal A/F' is reversed in the period shorter than rich time delay TDR like the time  $t_5$ ,  $t_6$ , and  $t_7$ . Time is taken for the delay counter CDLY to reach maximum TDR, and, as a result, air-fuel ratio signal A/F' after delay processing is reversed in time  $t_8$ . That is, air-fuel ratio signal A/F' after delay processing becomes stable compared with air-fuel ratio signal A/F before delay processing. Thus, the air-fuel ratio correction factor FAF shown in drawing 4 (D) based on stable air-fuel ratio signal A/F' after delay processing is obtained.

[0028] Next, the 2nd feed back control of air-fuel ratio by the downstream  $O_2$  sensor 15 is explained. As the 2nd feed back control of air-fuel ratio, the skip amount RSR as 1st air-fuel ratio feedback control parameter,

RSL, There are a system which makes variable comparison voltage  $V_{R1}$  of output VOM of the constant of integration KIR, KIL, the time delays TDR and TDL, or the upstream  $O_2$  sensor 13, and a system which introduces air-fuel ratio correction factor FAF of \*\* 2nd2.

[0029] For example, if a control air-fuel ratio can be shifted to a rich side and another side and the Lean skip amount RSL are enlarged even if a control air-fuel ratio can be shifted to a rich side and it will make the Lean skip amount RSL small, if the rich skip amount RSR is enlarged, A control air-fuel ratio can be shifted to the Lean side, and even if it makes the rich skip amount RSR small, a control air-fuel ratio can be shifted to the Lean side. Therefore, an air-fuel ratio is controllable by amending the rich skip amount RSR according to the output of the downstream  $O_2$  sensor 15. If a control air-fuel ratio can be shifted to a rich side and another side and the Lean constant of integration KIL are enlarged even if a control air-fuel ratio can be shifted to a rich side and it will make the Lean constant of integration KIL small, if the rich constant of integration KIR is enlarged, A control air-fuel ratio can be shifted to the Lean side, and even if it makes the rich constant of integration KIR small, a control air-fuel ratio can be shifted to the Lean side. Therefore, an air-fuel ratio is controllable by amending the rich constant of integration KIR and the Lean constant of integration KIL according to the output of the downstream  $O_2$  sensor 15. If the Lean time delay (-TDL) is set up small greatly [ TDR / rich time delay ], the control air-fuel ratio can shift to a rich side, and if a rich time delay (TDR) is set up small greatly [ time delay / (-TDL) / Lean ] conversely, the control air-fuel ratio can shift to the Lean side. That is, an air-fuel ratio is controllable by amending the time delays TDR and TDL according to the output VOS of the downstream  $O_2$  sensor 15. If comparison voltage  $V_{R1}$  is enlarged, a control air-fuel ratio can be shifted to a rich side further again, and if comparison voltage  $V_{R1}$  is made small, a control air-fuel ratio can be shifted to the Lean side. Therefore, an air-fuel ratio is controllable by amending comparison voltage  $V_{R1}$  according to the output VOS of the downstream  $O_2$  sensor 15.

[0030] Making variable these skip amounts, a constant of integration, a time delay, and comparison voltage by a downstream  $O_2$  sensor has the strong point in each. For example, adjustment of a very delicate air-fuel ratio is possible by making a time delay variable, and good control of a response is possible, without lengthening the feedback period of an air-fuel ratio like a time delay by making a skip amount variable. Therefore, naturally these two or more variable quantity is put together, and may be used.

[0031] Next, the double  $O_2$  sensor system which made variable the skip amount as an air-fuel ratio feedback control parameter is explained. Drawing 5 and drawing 6 are the 2nd [ based on the output VOS of the downstream  $O_2$  sensor 15 ] air-fuel ratio feedback control routine, and are performed 512 ms of

predetermined time, for example, every. In Steps 501-506, it is distinguished whether it is an article affair in which the closed-loop-control conditions by downstream  $O_2$  sensor 15 output are satisfied. For example, it is adding to the failure (Step 501) of the closed-loop conditions by the upstream  $O_2$  sensor 13, When the cooling water temperature THW is below a predetermined value (for example, 70 \*\*) (Step 502), When the throttle valve 16 is full close (LL= "1") (Step 503), When secondary air is introduced based on revolving speed  $N_g$ , the vehicle speed, signal LL of the idle switch 17, the cooling water temperature THW, etc. (Step 504), At the time of a light load (when suction-air-quantity  $Q/N_g$  per organization 1 rotation is smaller than

predetermined value  $X_1$ ) (Step 505). Closed-loop conditions have an abortive time (Step 506) of the downstream  $O_2$  sensor 15 not being activated, etc., and the case of others is closed-loop condition formation. If it is closed-loop condition failure, it will progress to Step 519 and the air-fuel ratio feedback flag XSFB will be reset ("0"), if it is closed-loop condition formation, it will progress to Step 508 and the air-fuel ratio feedback flag XSFB will be set ("1").

[0032]The flow of Steps 509-518 is explained. or [ with a rich air-fuel ratio / that Step 509 carries out the A/D conversion of the output VOS of the downstream  $O_2$  sensor 15, incorporates it, and distinguishes whether VOS is below comparison voltage  $V_{R2}$  (for example,  $V_{R2}=0.55V$ ) at Step 510 / which is got blocked ] -- it is distinguished whether you are Lean. Although comparison voltage  $V_{R2}$  is set up in the upper stream of the catalytic converter 12, and the lower stream in consideration of it differing from degradation speed that the output characteristics under the influence of raw gas differ etc. more highly than comparison voltage  $V_{R1}$  of the output of the upstream  $O_2$  sensor 13, this setting out may be arbitrary. As a result, if it is  $VOS \leq V_{R2}$  (Lean), it will progress to Steps 511 and 512, 513, and if it is  $VOS > V_{R2}$  (rich), it will progress to Step 514, 515, 516. Namely, it is referred to as  $RSR \leftarrow RSR + \Delta RS$  ( $\Delta RS$  is constant value) in Step 511, That is, increase the rich skip amount RSR, make an air-fuel ratio shift it to a rich side, and in Step 512, 513. Guard RSR at the maximum MAX ( $=0.075$ ) and it is referred to as  $RSR \leftarrow RSR - \Delta RS$  at another side and Step 514, That is, decrease the rich skip amount RSR, an air-fuel ratio is made to shift to the Lean side, and RSR is guarded at the minimum MIN ( $=0.025$ ) by Step 515, 516. The minimum MIN is a value of the level with which transient flattery nature is not spoiled, and the maximum MAX is a value of the level which aggravation of drivability does not generate by air fuel ratio fluctuation.

[0033]The Lean skip amount RSL is set to  $RSL \leftarrow 0.1 - RSR$  in Step 517. That is, it is referred to as  $RSR + RSL = 0.1$ . In Step 518, the skip amount RSRSL is stored in RAM105, it progresses to Step 520, and a routine is ended.

[0034]Drawing 7 is an injection-quantity operation routine, and is performed 360 degrees of a specified crank angle, for example, every. In Step 701, from RAM105, intake-air-content-data Q and rotational-speed-data  $N_e$  are read, and the basic injection quantity TAUP (injection time when TAUP obtains theoretical air fuel ratio) is calculated. For example, it is considered as  $TAUP \leftarrow \alpha \cdot Q / N_e$  ( $\alpha$  is a constant). In Step 702, the last injection quantity TAU is calculated by  $TAU \leftarrow TAUP - \beta \cdot \gamma$ .  $\beta$  and  $\gamma$  are correction amounts which become settled with other operational status parameters. Subsequently, the injection quantity TAU is set to the down counter 108, and the flip-flop 109 is set and fuel injection is made to start at Step 703. And this routine is ended at Step 704.

[0035]If time to be equivalent to the injection quantity TAU like \*\*\*\* passes, with the output signal of the down counter 108, the flip-flop 109 will be reset and fuel injection will be ended. Next, catalyst warming-up control of this example is explained. In this example, the catalyst 12 is being activated based on the upstream  $O_2$  sensor 13 and the downstream  $O_2$  sensor 15, or (is exhaust-air-purification capability demonstrated?) the control circuit 10 judges whether it is no so that it may mention later, When the catalyst 12 is judged to be in a non-active state, while carrying out the angle of delay of the ignition timing, the opening of above-mentioned ISC valve 22 is made to increase.

[0036]By carrying out the angle of delay of the organization ignition timing, in order for combustion in each cylinder to arise near the exhaust stroke, an exhaust-gas temperature rises, by making the opening of ISC valve 22 increase further, engine intake air quantity increases and exhaust gas volume increases. For this reason, the temperature of the exhaust gas which flows into the catalyst 12 rises, and since an exhaust gas flow rate moreover also increases, warming up of the catalyst 12 is promoted. If the temperature of the catalyst 12 rises by the above-mentioned warming-up operation and the catalyst 12 is activated, the control circuit 10 will set the opening of ISC valve 22 as the optimal opening which becomes settled according to operational status while it carries out the tooth lead angle of the organization ignition timing and setting it as optimal ignition timing. When the catalyst 12 is activated and a normal exhaust-air-purification operation is started by this, ignition timing and ISC valve 22 opening will usually return to the value at the time of operation promptly.

[0037]Hereafter, catalyst warming-up control of this example is divided into the determining operation of the active state of \*\* catalyst, and warming-up operation of \*\* catalyst, and is explained.

[0038]\*\* Judge whether the catalyst 12 is in an active state using  $O_2$  storage operation of the catalyst 12 in determining operation this example of a catalytic activity state. That is,  $O_2$  storage operation which emits the oxygen to which it stuck when the three way component catalyst adsorbed surplus oxygen under exhaust air when an exhaust air fuel ratio is generally Lean and the exhaust air fuel ratio became rich is performed. If feedback control of the organization 1 is carried out as mentioned above based on the output of the  $O_2$  sensors 13 and 15, As shown in drawing 4, an engine air fuel ratio (FAF) will be periodically changed between a rich air fuel ratio and a lean air fuel ratio, and the air-fuel ratio of the exhaust air which flows into a catalyst will also be periodically changed between a rich air fuel ratio and a lean air fuel ratio. When a catalyst is activated and it is functioning normally, When the air-fuel ratio of the flowing exhaust air sways to the Lean side by above-mentioned  $O_2$  storage operation, a catalyst is adsorbed in oxygen of the surplus under exhaust air, Since the adsorbed oxygen is emitted to exhaust air when the air-fuel ratio of the flowing exhaust air sways to a rich side, the air fuel ratio fluctuation of the exhaust air which passed the catalyst becomes small, and is maintained near the theoretical air fuel ratio.

[0039]However, since  $O_2$  storage operation of the catalyst 12 falls when a catalyst is in a non-active state and is not functioning normally, the air fuel ratio fluctuation of the exhaust air which passed the catalyst becomes large, and it comes to change it periodically in connection with the air fuel ratio fluctuation of the exhaust air which flows into a catalyst. Therefore, it is correctly detectable by measuring upstream  $O_2$  sensor 13 output and downstream  $O_2$  sensor 15 output whether the catalyst 12 is being activated.

[0040]Drawing 8 (A) (B) shows change of the  $O_2$  sensor 13 output VOM [ of the catalyst 12 upstream of air-fuel ratio feedback system Messrs. ], and downstream  $O_2$  sensor 15 output VOS, Drawing 8 (A) About the case where the catalyst 12 is activated and it is functioning normally, it is drawing 8 (B). The case where the catalyst 12 is in a non-active state is shown, respectively. As air-fuel ratio feedback system Messrs. were shown in drawing 4, in order that change may be repeated periodically [ an engine air fuel ratio ] between a rich air fuel ratio and a lean air fuel ratio, Upstream  $O_2$  sensor 13 output VOM will also repeat a periodic change between a rich air fuel ratio equivalent output (for example, 0.9 volt) and a lean air fuel ratio

equivalent output (for example, 0.1 volt) (refer to drawing 8 (A) (B) VOM).

[0041]On the other hand, when the catalyst 12 is in an active state and is functioning normally, Since the air fuel ratio fluctuation of the exhaust air which passed the catalyst is eased by  $O_2$  storage operation of the catalyst 12, Even if it is changing the exhaust air fuel ratio of the catalyst upstream, the exhaust air fuel ratio of the catalyst downstream is maintained by abbreviated theoretical air fuel ratio, and the downstream  $O_2$  sensor 15 output VOS is changed in between a rich side and the Lean sides a long cycle (refer to drawing 8 (A) VOS). In this state, it is drawing 8 (A). The locus length of the downstream  $O_2$  sensor 15 output VOS is comparatively small, and the area of the portion surrounded by the output VOS and reference voltage  $V_{R2}$  is comparatively large so that it may be shown.

[0042]When the catalyst 12 is in a non-active state, The exhaust air fuel ratio of the catalyst 12 downstream comes to repeat the same periodic change with exhaust air fuel ratio change of the upstream for the fall of  $O_2$  storage operation of the catalyst 12, The downstream  $O_2$  sensor 15 output VOS comes (refer to drawing 8 (B)) to repeat the same change as upstream  $O_2$  sensor 13 output VOM. In this state, it is drawing 8 (B). The locus length of the downstream  $O_2$  sensor 15 output VOS becomes comparatively large, and the area of the portion surrounded by the output VOS and reference voltage  $V_{R2}$  becomes comparatively small so that it may be shown.

[0043]In this example, the control circuit 10 The ratio of locus length LVOS of the downstream  $O_2$  sensor 15 output VOS, and locus length LVOM of upstream  $O_2$  sensor 13 output VOM, LRATIO (LRATIO=LVOS/LVOM) – and, The area ARATIO (ARATIO=AVOS/AVOM) surrounded by the area AVOS and upstream  $O_2$  sensor 13 output VOM which are surrounded by the downstream  $O_2$  sensor 15 output VOS and reference voltage  $V_{R2}$ , and reference voltage  $V_{R1}$  is calculated, When LRATIO and ARATIO have a fixed relation, it is judged that the catalyst 12 is in a non-active state.

[0044]That is, the catalyst 12 will be from a non-active state in an active state, the locus length ratio LRATIO becomes small as the exhaust-air-purification capability of a catalyst increases, and the surface ratio ARATIO becomes large conversely. Then, in this example, when the relation between the locus length ratio LRATIO and the surface ratio ARATIO is in the field shown with the slash of drawing 9 using a judgment map as shown in drawing 9, it is judged that the catalyst 12 is in a non-active state.

[0045]The locus length ratio LRATIO which broke the locus length and area of the downstream  $O_2$  sensor 15 output VOS by this example in the locus length and area of upstream  $O_2$  sensor 13 output VOM, respectively. ARATIO is used in order to eliminate the influence by change of the engine air fuel ratio upset condition by operational status and to judge catalytic activation correctly. In the judgment map of drawing 9, when the locus length ratio LRATIO is below a predetermined value (K1), have judged with the catalyst having been activated irrespective of the value of the surface ratio ARATIO, but. If the catalyst is being activated when the engine air fuel ratio is controlled by small amplitude focusing on theoretical air fuel ratio, this, It is because it has a possibility of producing incorrect judgment when the exhaust air fuel ratio of the catalyst downstream stops almost changing, been in agreement with theoretical air fuel ratio, and becomes very small [ AVOS and AVOM ] and activation is judged based on ARATIO.

[0046] Drawing 10 to drawing 13 is a flow chart which shows the routine of the above-mentioned catalytic activation judgment performed by the control circuit 10. This routine is performed 4 ms of fixed time, for example, every. it is judged [ drawing 10 and ] whether if it comes out and a routine starts, the conditions for a catalytic activation judging will be satisfied in Steps 1001-1004. Here, the conditions for a judgment are (1). The 1st Air Fuel Ratio Control by upstream  $O_2$  sensor 13 output is carried out, Namely, the thing for which the value of the flag XMFB (drawing 2, Steps 224 and 225) is set to 1 (Step 1001), (2) It is not detected that the output of the upstream  $O_2$  sensor 13 has stopped at the Lean side by RIN monitor beyond in predetermined time (Step 1002), (3) It is not detected that upstream  $O_2$  sensor 13 output has stopped at a rich side by rich monitor beyond in predetermined time (Step 1003), (4) The 2nd Air Fuel Ratio Control by downstream  $O_2$  sensor 15 output is carried out, That is, it is that the value of the flag XSFB (drawing 5, Steps 508 and 519) is set to 1 (Step 1004) etc., and only when all the above-mentioned conditions are satisfied, a 1005 or less-step catalytic activation judging is performed.

[0047] The above-mentioned conditions (2) Having provided (3), Even if it is [ feed-back-control-of-air-fuel-ratio ] under execution by upstream  $O_2$  sensor 13 output, it is because a value with the effective area AVOM may not be obtained if it is changing while upstream  $O_2$  sensor 13 output VOM had inclined toward the Lean and rich side. When all of the above-mentioned conditions are materialized, it progresses to drawing 11 and Step 1005, and the locus length LVOM and the area AVOM of upstream  $O_2$  sensor 13 output calculate a routine by the following formulas.

[0048]  
 $LVOM \leftarrow LVOM + |VOM - VOM_{i-1}|$   $AVOM \leftarrow AVOM + |VOM - V_{R1}|$  -- here,  $VOM_{i-1}$  shows the value of VOM at the time of routine execution last time. That is, in this example, from change of upstream  $O_2$  sensor 13 output VOM for every routine execution, as shown in drawing 13, the locus length LVOM and the area AVOM are approximately determined as an integral value. Drawing 13 shows the case where an actually more quite long sampling period is taken to change of a sensor output, for explanation. In order to calculate locus length and area correctly, it may be made to calculate locus length and area in consideration of the waveform (inclination) of an output locus.

[0049] Subsequently, in Step 1006, the locus length LVOS and the area AVOS of downstream  $O_2$  sensor 15 output calculate by the following formulas like the above.  
 $At\ LVOS \leftarrow LVOS + |VOS - VOS_{i-1}|$   $AVOS \leftarrow AVOS + |VOS - V_{R2}|$  and Step 1007, the value of  $VOM_{i-1}$  and  $VOS_{i-1}$  is updated in preparation for next routine execution.

[0050] After the above-mentioned operation, while it progresses to drawing 12 and Step 1009 and a routine counts up the counter CTIME, at Step 1010, it is judged whether the value of CTIME exceeded predetermined value  $C_0$ . Here, when  $C_0$  judges catalytic activation, it is the routine repeat frequency equivalent to the time which can obtain significant locus length and area. It is needed that it is more than several times of the richness of upstream  $O_2$  sensor 13 output and the number of times of reversal between Lean at least, and such an exact activation judging of this time is attained that this time is long.

[0051] When the above-mentioned time has passed at Step 1010, the locus length ratio LRATIO and the

surface ratio ARATIO are calculated as  $LRATIO \leftarrow LVOS/LVOM$  and  $ARATIO \leftarrow AVOS/AVOM$  at Step 1011. [0052]Subsequently, at Steps 1012-1014, it is judged whether the catalyst 12 is being activated from the relation shown in drawing 9 using the locus length ratio LRATIO and the surface ratio ARATIO which were calculated by the above. That is, at Step 1012, it is judged whether the locus length ratio LRATIO is more than predetermined value K1 (refer to drawing 9), since it will be thought that the catalyst 12 is being activated if it is  $LRATIO < K1$ , it progresses to Step 1014 and the value of catalytic activity status-flags FACT is set as 1.

[0053]moreover -- progressing to Step 1012, if it is  $LRATIO \geq K1$  -- the ratio of the locus length ratio LRATIO and the surface ratio ARATIO -- it is judged whether the value of  $LRATIO/ARATIO$  is more than predetermined value K2 (refer to drawing 9). If it is  $LRATIO/ARATIO < K2$ , if the relation between the locus length ratio LRATIO and the surface ratio ARATIO is not contained in the slash field of drawing 9, Since it will be thought that a catalyst is in a non-active state if the value of the flag FACT is set as 1 at Step 1014 like the above and it is in  $LRATIO/ARATIO \geq K2$ , i.e., the slash field of drawing 9, the value of the flag FACT is set as zero at Step 1013. Variables, such as CTIME, LVOM, AVOM, LVOS, AVOS,  $VOM_{i-1}$ , and  $VOS_{i-1}$ , are cleared at the after-end step 1015, and this routine ends the above-mentioned step.

[0054]\*\* Warming-up operation drawing 14 of the catalyst shows the flow chart of the catalyst warming-up operation based on the above-mentioned catalytic activation decision result. This routine is performed by the control circuit 10, for example at drawing 12 and an interval shorter than predetermined time  $C_0$  of Step 1010. In drawing 14, a start of a routine will judge whether the catalyst 12 is being activated from the value of the catalytic activation flag FACT at Step 1401.

[0055]When the catalyst 12 is in a non-active state ( $FACT=0$ ), while the angle of delay of the organization ignition timing (BTDC) AIG is carried out only the predetermined value A1 at Step 1402, opening DISC of ISC valve 22 increases only the predetermined value A2 at Step 1403. When the catalyst 12 is being activated at Step 1401 ( $FACT=1$ ), the tooth lead angle of the ignition timing AIG is carried out only A1 at Steps 1404 and 1405, and opening DISC of ISC valve 22 decreases only by A2.

[0056]Subsequently, in Steps 1406-1409, the ignition timing AIG set up by the above is guarded by permission maximum angle-of-delay ignition-timing  $AIG_{MAX}$  and optimal-ignition-timing  $AIG_{OPT}$  of an organization. That is, the angle of delay of the ignition timing AIG is not carried out from  $AIG_{MAX}$ , and a tooth lead angle is not carried out from optimal-ignition-timing  $AIG_{OPT}$ . Here, optimal-ignition-timing  $AIG_{OPT}$  is a value set up by the routine (not shown) separately performed by the control circuit 10 according to engine operation conditions.

[0057]At Steps 1410-1413, ISC valve opening DISC is similarly guarded by allowable maximum opening  $DISC_{MAX}$  and optimal opening  $DISC_{OPT}$  set up according to operational status. Subsequently, at Step 1414, the ignition timing AIG and ISC valve opening DISC which were set up by the above are stored in RAM105, and a routine is ended.

[0058]When the catalyst 12 is in a non-active state, the specified quantity [ every ] angle of delay of the organization ignition timing is carried out for every routine execution by the above-mentioned routine execution, and by it, an ISC valve opening increases the specified quantity every. After the temperature of the catalyst 12 rises by this and the catalyst 12 is activated, ignition timing and an ISC valve opening, until

the optimal ignition timing and the optimal opening according to an engine operation state are obtained -- every routine execution -- respectively -- a specified quantity [ every ] tooth lead angle -- and it will decrease, and after reaching optimal ignition timing and the optimal opening, it will be maintained by the state, respectively.

[0059]In this example, in order to avoid the abrupt change of ignition timing and an ISC valve opening, set it as the variation A1 and the quantity in which A2 is comparatively small, instead have set up the routine execution interval comparatively short (at for example, drawing 12 and an interval shorter than predetermined time  $C_0$  of Step 1010), but. It is also possible to set the variation A1 and A2 as a comparatively big quantity, and to set up the real line spacing of this routine comparatively long (at for example, interval longer than the above-mentioned  $C_0$ ).

[0060]As mentioned above, since opening increase of the angle of delay of ignition timing and an ISC valve is performed and the temperature of a catalyst continues rising when a catalyst is in a non-active state according to this example, even when activation temperature rises by degradation of a catalyst, it becomes possible to activate a catalyst certainly for a short time. Since the tooth lead angle of ignition timing and ISC valve opening reduction are conversely performed after a catalyst is activated, useless catalyst warming-up operation is prevented from catalyst warming-up operation always being performed in the necessary minimum range, and being performed.

[0061]When degradation of a catalyst advances substantially, the case where it stops demonstrating exhaust-air-purification capability with a sufficient catalyst also by catalyst warming-up operation can be considered. Although not shown in drawing 14, since it is coped with in such a case, it is also possible to generate an alarm signal, when the state (drawing 14 step 1407) where the angle of delay of the ignition timing was carried out to the maximum carries out fixed time continuation, and to report the abnormalities of a catalyst to a driver.

[0062]

[Effect of the Invention]In this invention, only when direct detection of the existence of activation of a catalyst was carried out as mentioned above and a catalyst was in a non-active state, it was made to perform catalyst warming-up operation.

Therefore, while being able to activate a catalyst certainly irrespective of the degradation state of a catalyst for a short time, the effect that useless catalyst warming-up operation can be prevented from being performed is done so.

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TECHNICAL FIELD

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[Industrial Application]This invention relates to the exhaust emission control device which can perform suitable catalyst warming-up operation according to the grade of degradation of a three way component catalyst in detail about the exhaust emission control device of an internal-combustion engine.

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PRIOR ART

[Description of the Prior Art]The exhaust emission control device of the internal-combustion engine which has arranged the catalytic converter which used for the flueway of the internal-combustion engine simultaneously the three way component catalyst which can be purified for HC under exhaust air, CO, and three detrimental constituents of  $\text{NO}_x$  is used more widely than before. Generally, unless the three way component catalyst used for the above exhaust emission control devices becomes the temperature beyond a certain temperature (activation temperature), it does not demonstrate exhaust-air-purification capability. For this reason, warming-up operation of what is called a catalyst of raising the temperature of the exhaust air which passes a catalyst by carrying out the angle of delay of the organization ignition timing, for example or other means, and making catalyst temperature reaching activation temperature at an early stage is performed at the time of start up between the organization colds, etc.

[0003]On the other hand, the activation temperature of a catalyst always is not constant, and with a new catalyst, in order for active temperature to show the tendency to go up as activation temperature is comparatively low and degradation of a catalyst progresses, it is necessary to perform warming-up operation of the above-mentioned catalyst according to the deterioration degree of a catalyst. For example, to JP,60-153473,A. Catalyst temperature is detected, and when this catalyst temperature is below the prescribed temperature defined beforehand, while carrying out the angle of delay of the organization ignition timing and performing catalyst warming-up operation, the exhaust emission control device of the internal-combustion engine it was made to raise the above-mentioned prescribed temperature along with the increase in the cumulative operating time of an organization is indicated.

[0004]Since it is thought that the deterioration degree of a catalyst advances as a hour of use, i.e., the cumulative operating time of an organization, increases, the activation temperature of a catalyst is also considered to become high as organization cumulative operating time increases. It sets up beforehand become high in the device of the above-mentioned gazette, as organization cumulative operating time increases said prescribed temperature, When the actually detected catalyst temperature is below the above-mentioned prescribed temperature, catalyst warming up by the ignition-timing angle of delay is performed as what the catalyst is not activating and catalyst temperature becomes more than the above-mentioned prescribed temperature, it is made to suspend catalyst warming up as what the catalyst activated.

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EFFECT OF THE INVENTION

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[Effect of the Invention]In this invention, only when direct detection of the existence of activation of a catalyst was carried out as mentioned above and a catalyst was in a non-active state, it was made to perform catalyst warming-up operation.

Therefore, while being able to activate a catalyst certainly irrespective of the degradation state of a catalyst for a short time, the effect that useless catalyst warming-up operation can be prevented from being performed is done so.

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TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention]However, judgment whether catalyst temperature reached the prescribed temperature determined based on the cumulative operating time of an organization like the device of above-mentioned JP,60-153473,A and whether the catalyst was activated with the chisel may produce a problem actually. That is, since the activation temperature of a catalyst is not determined by only the hour of use and changes the degradation state of a catalyst with the condition of use of an organization, or dispersion for every product, even if it is the same hour of use (cumulative operating time), the activation temperature of a catalyst may not necessarily be in agreement. For this reason, if the existence of the activity of a catalyst is judged [ whether catalyst temperature reached prescribed temperature and ] with the chisel like the device of the above-mentioned gazette, In spite of fully not activating the catalyst actually, catalyst warming-up operation will stop, and activation of a catalyst is overdue, and exhaust property gets worse, or, Since the catalyst warming-up operation by the ignition-timing angle of delay is continued in spite of fully activating the catalyst actually, problems, such as a fall of an engine output and fuel consumption increase, arise.

[0006]In order to solve this problem, it is necessary to detect the existence of activation of a catalyst indirectly using catalyst temperature etc., but to detect the existence of activation of a catalyst directly, and to control warming-up operation of a catalyst based on this detection result. An object of this invention is to provide the exhaust emission control device of the internal-combustion engine which direct detection of the existence of activation of a catalyst is carried out, and can perform catalyst warming-up operation in view of the above.

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MEANS

[Means for Solving the Problem]An upstream air fuel ratio sensor which according to this invention is formed in an upstream flueway of a three way component catalyst provided in a flueway of an internal-combustion engine, and this three way component catalyst, and detects an exhaust air fuel ratio of the three way component catalyst upstream, A downstream air fuel ratio sensor which is formed in a downstream flueway of said three way component catalyst, and detects an exhaust air fuel ratio of the three way component catalyst downstream, An air-fuel ratio control means which controls an air-fuel ratio of said organization based on said upstream air-fuel ratio sensor output at least, A catalyst non-active-state detection means to detect that said three way component catalyst is in a non-active state based on said upstream air-fuel ratio sensor output and said downstream air-fuel ratio sensor output, When it is detected a catalyst temperature-up means to raise temperature of said three way component catalyst, and that said three way component catalyst is in a non-active state, an exhaust emission control device of an internal-combustion engine provided with a catalytic activation means to perform operation of controlling said three way component catalyst temperature-up means, and raising temperature of said three way component catalyst is provided.

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OPERATION

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[Function]It detects that a catalyst non-active-state detection means has a three way component catalyst in a non-active state based on an upstream air-fuel ratio sensor output and a downstream air-fuel ratio sensor output, and a catalytic activation means warms up a catalyst, only when it is detected by a catalyst non-active-state detection means that a catalyst is in a non-active state. For this reason, when the catalyst is not actually being activated irrespective of catalyst temperature, warming-up operation is performed, and since warming-up operation is suspended when a catalyst is actually activated, suitable warming-up operation is performed according to the deterioration degree of a catalyst.

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EXAMPLE

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[Example]Hereafter, the example of this invention is described using an accompanying drawing. Drawing 1 is the whole internal-combustion engine schematic diagram which applied the exhaust emission control device of this invention. In drawing 1, the air flow meter with which provide 1 in an internal combustion engine body, 2 was provided in the suction passage, and 3 was provided in the suction passage is shown. Direct measuring of the suction air quantity is carried out, the movable vane type air flow meter etc. which contained the potentiometer are used, and the air flow meter 3 generates the output signal of the analog voltage proportional to suction air quantity. This output signal is inputted into A/D converter 101 with a built-in multiplexer of the control circuit 10. The crank angle sensor 5 which converts into a crank angle and generates the pulse signal for reference position detection every 720 degrees, and the crank angle sensor 6 which converts into a crank angle and generates the pulse signal for crank angle detection every 30 degrees are formed for the axis in the distributor 4, respectively. The pulse signal of these crank angle sensors 5 and 6 is supplied to the input/output interface 102 of the control circuit 10, among these the output of the crank angle sensor 6 is supplied to the interruption terminal of CPU103.

[0010]The fuel injection valve 7 for supplying application-of-pressure fuel to an inlet port from a fuel supply system for every cylinder is formed in the suction passage 2. The idle switch 17 which generates the signal which shows whether the throttle valve 16 is in a full-close state, i.e., LL signal, is formed in the throttle valve 16 of the suction passage 2. This idle status-out-put signal LL is supplied to the input/output interface 102 of the control circuit 10.

[0011]In this example, the bypass channel 21 which bypasses the throttle valve 16, and the idle speed control valve (ISC valve) 22 which controls the air content which flows through this bypass channel 21 are formed in the suction passage 2. It is used for ISC valve 22 being a flow control valve driven with the actuator of proper forms, such as a stepper motor, operating with the output signal from the control circuit 10, adjusting the engine intake air quantity at the time of an idle, and controlling the idle rpm of an organization to target revolving speed.

[0012]In this example, ISC valve 22 functions by raising organization idle rpm also as a part of catalyst temperature-up means to increase the amount of exhaust streams and to raise catalyst temperature, when the catalyst is not being activated like the after-mentioned. The water temperature sensor 9 for detecting the temperature of cooling water is formed in the engine water jacket 8 of the cylinder block of the main part 1 of an organization. The water temperature sensor 9 generates the electrical signal of the analog voltage according to the temperature of cooling water. This output is also supplied to A/D converter 101.

[0013]The catalytic converter 12 which accommodates the three way component catalyst which purifies simultaneously the three detrimental constituents HC and CO and NO<sub>x</sub> in exhaust gas is formed in the downstream exhaust system from the exhaust manifold 11 of the organization 1. The upstream air fuel ratio sensor (this example O<sub>2</sub> sensor) 13 and the downstream air fuel ratio sensor (this example O<sub>2</sub> sensor) 15 are formed in the exhaust manifold 11 of the upstream of the catalytic converter 12, and the exhaust pipe 14 of the downstream of the catalytic converter 12, respectively.

[0014]The O<sub>2</sub> sensors 13 and 15 detect the oxygen component concentration in exhaust gas, and generate the output voltage from which an air-fuel ratio differs according to the Lean side and a rich side to theoretical air fuel ratio. The output voltage of the O<sub>2</sub> sensors 13 and 15 is supplied to A/D converter 101 of the control circuit 10. It is the secondary air introduction inlet valve which 18 showed to drawing 1, and is for supplying secondary air to the exhaust manifold 11 from air supplies, such as an air pump which is not illustrated at the time of a slowdown or an idol, etc., and reducing HC and CO emission.

[0015]The control circuit 10 is constituted, for example as a microcomputer, and ROM104, RAM105, backup RAM106, and clock generation circuit 107 grade other than A/D-converter 101, input/output interface 102, and CPU103 are provided. In this example, the control circuit 10 performs basic control, such as fuel injection control of the organization 1, and ignition timing control, and also. The function as each means indicated to claims 1, such as an air-fuel ratio control means which controls an engine air fuel ratio like the after-mentioned, a catalyst non-active-state detection means to detect whether the catalyst 12 is in an active state, and a catalytic activation means to control the angle of delay and ISC valve 22 of organization ignition timing, and to perform catalyst warming up, is achieved.

[0016]In the control circuit 10, it is for the down counter 108, the flip-flop 109, and the drive circuit 110 controlling the fuel injection valve 7. That is, in the below-mentioned routine, if the fuel oil consumption (injection time) TAU calculates, the injection time TAU will be preset by the down counter 108, and the flip-flop 109 will be set. As a result, the drive circuit 110 starts energization of the fuel injection valve 7. On the other hand, when the down counter 108 calculates a clock signal (not shown) and the output terminal is set to "1" level at the last, the flip-flop 109 is set and the drive circuit 110 stops energization of the fuel injection valve 7. That is, as for the fuel injection valve 7, only the above-mentioned fuel injection duration TAU will be energized, and the fuel of quantity according to the time TAU will be supplied to the combustion chamber of the organization 1.

[0017]The input/output interface 102 of the control circuit 10 is connected to the firing circuit 112. Ignition timing of the organization 1 is controlled.

That is, after inputting the reference crank angle pulse signal of the crank angle sensor 6 into the input/output interface 102, the control circuit 10 outputs an ignition signal to the firing circuit 112, whenever a crankshaft reaches predetermined angle of rotation, and it makes the spark plug (not shown) of each cylinder generate a spark. Ignition timing of the organization 1, the optimum value is stored in ROM104 of the control circuit 10 as a function of operating conditions, such as load (for example, suction air quantity per organization 1 rotation), and number of rotations.

The optimal ignition timing is determined according to an operating condition.

[0018]The intake air content data and cooling-water-temperature data of the air flow meter 3 are

incorporated by the A/D conversion routine performed for every predetermined time or specified crank angle, and are stored in the predetermined region of RAM105. That is, the intake air content data and cooling-water-temperature data in RAM105 are updated for every predetermined time. rotational speed data -- 30-degreeCA (crank angle) of the crank angle sensor 6 -- each time -- it calculates by interruption and is stored in the predetermined region of RAM105.

[0019]In this example, the control circuit 10 performs the 1st Air Fuel Ratio Control that controls an engine air fuel ratio based on upstream  $O_2$  sensor 13 output, and the 2nd Air Fuel Ratio Control that amends this 1st Air Fuel Ratio Control based on downstream  $O_2$  sensor 15 output. Hereafter, this the 1st and 2nd Air Fuel Ratio Control that are performed by the control circuit 10 using drawing 6 from drawing 2 are explained.

[0020]Drawing 2 and drawing 3 show the 1st air-fuel ratio feedback control routine that calculates the air-fuel ratio correction factor FAF based on the output of the upstream  $O_2$  sensor 13. This routine is performed 4 ms of predetermined time, for example, every. In Step 201, it is distinguished whether the closed-loop (feedback) conditions of the air-fuel ratio by the upstream  $O_2$  sensor 13 are satisfied. When cooling water temperature is below a predetermined value (for example, 70 °C), for example, under organization start up, During the increase in quantity after start up, warming-up increase in quantity, and power increase in quantity, during the fuel-oil-consumption increase in quantity for catalyst overheat prevention, when the output signal of the upstream  $O_2$  sensor 13 is not once reversed, each fuel cut middle class has abortive closed-loop conditions, and the case of others is closed-loop condition formation. When closed-loop conditions are abortive, it progresses to drawing 3 and Step 225, and the air-fuel ratio feedback flag XMFB is set to "0", it progresses to Step 226, and a routine is ended. It is good also considering the air-fuel ratio correction factor FAF as 1.0. On the other hand, in closed-loop condition formation, it progresses to Step 202.

[0021]or [ that carry out the A/D conversion of the output VOM of the upstream  $O_2$  sensor 13, incorporate it in Step 202, and an air-fuel ratio is rich by whether VOM is below comparison voltage  $V_{R1}$  at Step 203 ] -- it is distinguished whether you are Lean. Comparison voltage  $V_{R1}$  usually takes the voltage of the amplitude center of  $O_2$  sensor output, and is  $V_{R1}=0.45V$  in this example. Steps 204-209 and Steps 210-215 show the setting operation of FU air-fuel ratio flag F1 based on the value of upstream  $O_2$  sensor 13 output judged at Step 203.

[0022]Air-fuel ratio flag F1 is a flag with which the exhaust air fuel ratio of the catalyst 12 upstream shows Rich or Lean. the value of flag F1 -- countdown (at the time of a lean air fuel ratio) or count-up (at time of rich air fuel ratio) operation of the delay counter CDLY -- a time delay (TDL.) predetermined in upstream (Steps 206 and 212)  $O_2$  sensor 13 output More than TDR is changed into 1 (rich)-0 (Lean), or 0-1, when rich or it is held at Lean (Steps 207-209, Steps 213-215).

TDL (Steps 207 and 208) is the Lean time delay for holding judgment that it is a rich condition even if the output of the upstream  $O_2$  sensor 13 changes from Rich to Lean here, It defines as a negative value, and

TDR (Steps 213 and 214) is a rich time delay for holding judgment that it is in the Lean state, even if the output of the upstream  $O_2$  sensor 13 changes from Lean richly, and it is defined by the positive value.

[0023]Next, in Step 216, it is distinguished whether the air-fuel ratio whether the numerals of air-fuel ratio flag F1 were reversed and after delay processing was reversed. If the air-fuel ratio is reversed, the reversal to Lean from Rich and the reversal to Rich from Lean will be distinguished with the value of air-fuel ratio flag F1 at Step 217. If it is reversal to Lean from Rich, the air-fuel ratio correction factor FAF will be increased in skip with  $FAF <- FAF + RSR$  at Step 218, and an air-fuel ratio will be amended to a rich side. If it is reversal to Rich from Lean conversely, at Step 219,  $FAF <- FAF - RSL$  and FAF will be decreased in skip, and an air-fuel ratio will be amended to the Lean side. That is, skip processing is performed.

[0024]If the numerals of air-fuel ratio flag F1 are not reversed at Step 216, integration treatment is performed at Step 220, 221, 222. That is, it distinguishes whether it is  $F1 = "1"$  at Step 220, if it is  $F1 = "0"$  (Lean), it will be considered as  $FAF <- FAF + KIR$  at Step 221, and if it is another side and  $F1 = "1"$  (rich), it will be considered as  $FAF <- FAF - KIL$  at Step 222. Here, the constant of integration KIRKIL is set up small enough as compared with the skip amount RSRSL, and is  $KIR(KIL) < RSR(RSL)$ . Therefore, Step 221 makes an air-fuel ratio shift to a rich side gradually in the state of Lean ( $F1 = "0"$ ), and Step 222 makes an air-fuel ratio shift to the Lean side gradually in a rich condition ( $F1 = "1"$ ).

[0025]Next, in Step 223, the air-fuel ratio correction factor FAF calculated at Step 218, 219, 221, 222 is guarded at the minimum, for example, 0.8, and is guarded at the maximum, for example, 1.2. When the air-fuel ratio correction factor FAF becomes large too much by a certain cause or it becomes small too much by this, it prevents controlling the air-fuel ratio of an organization by the value, and becoming the Oba richness and Oba Lean.

[0026]In Step 224, the air-fuel ratio feedback flag XMFB is set to "1", FAF calculated like \*\*\*\* is stored in RAM105, and this loop is ended at Step 226. Next, the case where this invention is applied to the double  $O_2$  sensor system which performs feed back control of air-fuel ratio using both output VOM of the upstream  $O_2$  sensor 13 and output VOS of the downstream  $O_2$  sensor 15 is explained.

[0027]Drawing 4 is drawing 2 and a timing diagram which explains supplementarily operation by the flow chart of drawing 3. If air-fuel ratio signal A/F of richness and the Lean distinction is obtained as output VOM of the upstream  $O_2$  sensor 13 shows to drawing 4 (A), as shown in drawing 4 (B), the delay counter CDLY will be counted up by a rich condition, and will be counted down in the state of Lean. As a result, as shown in drawing 4 (C), air-fuel ratio signal A/F' (equivalent to flag F1) by which delay processing was carried out is formed. For example, even if air-fuel ratio signal A/F' changes from Lean richly in time  $t_1$ , air-fuel ratio signal A/F' by which delay processing was carried out changes richly at time  $t_2$ , after only rich time delay TDR is held at Lean. Even if air-fuel ratio signal A/F changes from Rich to Lean in time  $t_3$ , air-fuel ratio signal A/F' by which delay processing was carried out changes to Lean in time  $t_4$ , after only an equivalent for the Lean time delay (-TDL) is held richly. However, if air-fuel ratio signal A/F' is reversed in the period shorter than rich time delay TDR like the time  $t_5$ ,  $t_6$ , and  $t_7$ . Time is taken for the delay counter CDLY to reach maximum TDR, and, as a result, air-fuel ratio signal A/F' after delay processing is reversed in time  $t_8$ . That is, air-fuel ratio signal A/F' after delay processing becomes stable compared with air-fuel ratio signal A/F before delay

processing. Thus, the air-fuel ratio correction factor FAF shown in drawing 4 (D) based on stable air-fuel ratio signal A/F' after delay processing is obtained.

[0028]Next, the 2nd feed back control of air-fuel ratio by the downstream  $O_2$  sensor 15 is explained. As the 2nd feed back control of air-fuel ratio, the skip amount RSR as 1st air-fuel ratio feedback control parameter, RSL, There are a system which makes variable comparison voltage  $V_{R1}$  of output VOM of the constant of integration KIR, KIL, the time delays TDR and TDL, or the upstream  $O_2$  sensor 13, and a system which introduces air-fuel ratio correction factor FAF of \*\* 2nd2.

[0029]For example, if a control air-fuel ratio can be shifted to a rich side and another side and the Lean skip amount RSL are enlarged even if a control air-fuel ratio can be shifted to a rich side and it will make the Lean skip amount RSL small, if the rich skip amount RSR is enlarged, A control air-fuel ratio can be shifted to the Lean side, and even if it makes the rich skip amount RSR small, a control air-fuel ratio can be shifted to the Lean side. Therefore, an air-fuel ratio is controllable by amending the rich skip amount RSR according to the output of the downstream  $O_2$  sensor 15. If a control air-fuel ratio can be shifted to a rich side and another side and the Lean constant of integration KIL are enlarged even if a control air-fuel ratio can be shifted to a rich side and it will make the Lean constant of integration KIL small, if the rich constant of integration KIR is enlarged, A control air-fuel ratio can be shifted to the Lean side, and even if it makes the rich constant of integration KIR small, a control air-fuel ratio can be shifted to the Lean side. Therefore, an air-fuel ratio is controllable by amending the rich constant of integration KIR and the Lean constant of integration KIL according to the output of the downstream  $O_2$  sensor 15. If the Lean time delay (-TDL) is set up small greatly [ TDR / rich time delay ], the control air-fuel ratio can shift to a rich side, and if a rich time delay (TDR) is set up small greatly [ time delay / (-TDL) / Lean ] conversely, the control air-fuel ratio can shift to the Lean side. That is, an air-fuel ratio is controllable by amending the time delays TDR and TDL according to the output VOS of the downstream  $O_2$  sensor 15. If comparison voltage  $V_{R1}$  is enlarged, a control air-fuel ratio can be shifted to a rich side further again, and if comparison voltage  $V_{R1}$  is made small, a control air-fuel ratio can be shifted to the Lean side. Therefore, an air-fuel ratio is controllable by amending comparison voltage  $V_{R1}$  according to the output VOS of the downstream  $O_2$  sensor 15.

[0030]Making variable these skip amounts, a constant of integration, a time delay, and comparison voltage by a downstream  $O_2$  sensor has the strong point in each. For example, adjustment of a very delicate air-fuel ratio is possible by making a time delay variable, and good control of a response is possible, without lengthening the feedback period of an air-fuel ratio like a time delay by making a skip amount variable. Therefore, naturally these two or more variable quantity is put together, and may be used.

[0031]Next, the double  $O_2$  sensor system which made variable the skip amount as an air-fuel ratio feedback control parameter is explained. Drawing 5 and drawing 6 are the 2nd [ based on the output VOS of the downstream  $O_2$  sensor 15 ] air-fuel ratio feedback control routine, and are performed 512 ms of predetermined time, for example, every. In Steps 501-506, it is distinguished whether it is an article affair in which the closed-loop-control conditions by downstream  $O_2$  sensor 15 output are satisfied. For example, it is adding to the failure (Step 501) of the closed-loop conditions by the upstream  $O_2$  sensor 13, When the

cooling water temperature THW is below a predetermined value (for example, 70 °) (Step 502), When the throttle valve 16 is full close (LL= "1") (Step 503), When secondary air is introduced based on revolving speed  $N_e$ , the vehicle speed, signal LL of the idle switch 17, the cooling water temperature THW, etc. (Step 504), At the time of a light load (when suction-air-quantity  $Q/N_e$  per organization 1 rotation is smaller than predetermined value  $X_1$ ) (Step 505). Closed-loop conditions have an abortive time (Step 506) of the downstream  $O_2$  sensor 15 not being activated, etc., and the case of others is closed-loop condition formation. If it is closed-loop condition failure, it will progress to Step 519 and the air-fuel ratio feedback flag XSFB will be reset ("0"), if it is closed-loop condition formation, it will progress to Step 508 and the air-fuel ratio feedback flag XSFB will be set ("1").

[0032]The flow of Steps 509-518 is explained. or [ with a rich air-fuel ratio / that Step 509 carries out the A/D conversion of the output VOS of the downstream  $O_2$  sensor 15, incorporates it, and distinguishes whether VOS is below comparison voltage  $V_{R2}$  (for example,  $V_{R2}=0.55V$ ) at Step 510 / which is got blocked ] -- it is distinguished whether you are Lean. Although comparison voltage  $V_{R2}$  is set up in the upper stream of the catalytic converter 12, and the lower stream in consideration of it differing from degradation speed that the output characteristics under the influence of raw gas differ etc. more highly than comparison voltage  $V_{R1}$  of the output of the upstream  $O_2$  sensor 13, this setting out may be arbitrary. As a result, if it is  $VOS \leq V_{R2}$  (Lean), it will progress to Steps 511 and 512,513, and if it is  $VOS > V_{R2}$  (rich), it will progress to Step 514,515,516. Namely, it is referred to as  $RSR < RSR + \Delta RS$  ( $\Delta RS$  is constant value) in Step 511, That is, increase the rich skip amount RSR, make an air-fuel ratio shift it to a rich side, and in Step 512,513. Guard RSR at the maximum MAX (=0.075) and it is referred to as  $RSR < RSR - \Delta RS$  at another side and Step 514, That is, decrease the rich skip amount RSR, an air-fuel ratio is made to shift to the Lean side, and RSR is guarded at the minimum MIN (=0.025) by Step 515,516. The minimum MIN is a value of the level with which transient flattery nature is not spoiled, and the maximum MAX is a value of the level which aggravation of drivability does not generate by air fuel ratio fluctuation.

[0033]The Lean skip amount RSL is set to  $RSL < 0.1 - RSR$  in Step 517. That is, it is referred to as  $RSR + RSL = 0.1$ . In Step 518, the skip amount RSRSL is stored in RAM105, it progresses to Step 520, and a routine is ended.

[0034]Drawing 7 is an injection-quantity operation routine, and is performed 360 degrees of a specified crank angle, for example, every. In Step 701, from RAM105, intake-air-content-data Q and rotational-speed-data  $N_e$  are read, and the basic injection quantity TAUP (Injection time when TAUP obtains theoretical air fuel ratio) is calculated. For example, it is considered as  $TAUP < \alpha \cdot Q / N_e$  ( $\alpha$  is a constant). In Step 702, the last injection quantity TAU is calculated by  $TAU < TAUP - \beta + \gamma$ .  $\beta$  and  $\gamma$  are correction amounts which become settled with other operational status parameters. Subsequently, the injection quantity TAU is set to the down counter 108, and the flip-flop 109 is set and fuel injection is made to start at Step 703. And this routine is ended at Step 704.

[0035]If time to be equivalent to the injection quantity TAU like \*\*\*\* passes, with the output signal of the down counter 108, the flip-flop 109 will be reset and fuel injection will be ended. Next, catalyst warming-up

control of this example is explained. In this example, the catalyst 12 is being activated based on the upstream O<sub>2</sub> sensor 13 and the downstream O<sub>2</sub> sensor 15, or (is exhaust-air-purification capability demonstrated?) the control circuit 10 judges whether it is no so that it may mention later, When the catalyst 12 is judged to be in a non-active state, while carrying out the angle of delay of the ignition timing, the opening of above-mentioned ISC valve 22 is made to increase.

[0036]By carrying out the angle of delay of the organization ignition timing, in order for combustion in each cylinder to arise near the exhaust stroke, an exhaust-gas temperature rises, by making the opening of ISC valve 22 increase further, engine intake air quantity increases and exhaust gas volume increases. For this reason, the temperature of the exhaust gas which flows into the catalyst 12 rises, and since an exhaust gas flow rate moreover also increases, warming up of the catalyst 12 is promoted. If the temperature of the catalyst 12 rises by the above-mentioned warming-up operation and the catalyst 12 is activated, the control circuit 10 will set the opening of ISC valve 22 as the optimal opening which becomes settled according to operational status while it carries out the tooth lead angle of the organization ignition timing and setting it as optimal ignition timing. When the catalyst 12 is activated and a normal exhaust-air-purification operation is started by this, ignition timing and ISC valve 22 opening will usually return to the value at the time of operation promptly.

[0037]Hereafter, catalyst warming-up control of this example is divided into the determining operation of the active state of \*\* catalyst, and warming-up operation of \*\* catalyst, and is explained.

[0038]\*\* Judge whether the catalyst 12 is in an active state using O<sub>2</sub> storage operation of the catalyst 12 in determining operation this example of a catalytic activity state. That is, O<sub>2</sub> storage operation which emits the oxygen to which it stuck when the three way component catalyst adsorbed surplus oxygen under exhaust air when an exhaust air fuel ratio is generally Lean and the exhaust air fuel ratio became rich is performed. If feedback control of the organization 1 is carried out as mentioned above based on the output of the O<sub>2</sub> sensors 13 and 15, As shown in drawing 4, an engine air fuel ratio (FAF) will be periodically changed between a rich air fuel ratio and a lean air fuel ratio, and the air-fuel ratio of the exhaust air which flows into a catalyst will also be periodically changed between a rich air fuel ratio and a lean air fuel ratio. When a catalyst is activated and it is functioning normally, When the air-fuel ratio of the flowing exhaust air sways to the Lean side by above-mentioned O<sub>2</sub> storage operation, a catalyst is adsorbed in oxygen of the surplus under exhaust air, Since the adsorbed oxygen is emitted to exhaust air when the air-fuel ratio of the flowing exhaust air sways to a rich side, the air fuel ratio fluctuation of the exhaust air which passed the catalyst becomes small, and is maintained near the theoretical air fuel ratio.

[0039]However, since O<sub>2</sub> storage operation of the catalyst 12 falls when a catalyst is in a non-active state and is not functioning normally, the air fuel ratio fluctuation of the exhaust air which passed the catalyst becomes large, and it comes to change it periodically in connection with the air fuel ratio fluctuation of the exhaust air which flows into a catalyst. Therefore, it is correctly detectable by measuring upstream O<sub>2</sub> sensor 13 output and downstream O<sub>2</sub> sensor 15 output whether the catalyst 12 is being activated.

[0040]Drawing 8 (A) (B) shows change of the O<sub>2</sub> sensor 13 output VOM [ of the catalyst 12 upstream of air-fuel ratio feedback system Messrs. ], and downstream O<sub>2</sub> sensor 15 output VOS, Drawing 8 (A) About the

case where the catalyst 12 is activated and it is functioning normally, it is drawing 8 (B). The case where the catalyst 12 is in a non-active state is shown, respectively. As air-fuel ratio feedback system Messrs. were shown in drawing 4, in order that change may be repeated periodically [ an engine air fuel ratio ] between a rich air fuel ratio and a lean air fuel ratio, Upstream  $O_2$  sensor 13 output VOM will also repeat a periodic change between a rich air fuel ratio equivalent output (for example, 0.9 volt) and a lean air fuel ratio equivalent output (for example, 0.1 volt) (refer to drawing 8 (A) (B) VOM).

[0041]On the other hand, when the catalyst 12 is in an active state and is functioning normally, Since the air fuel ratio fluctuation of the exhaust air which passed the catalyst is eased by  $O_2$  storage operation of the catalyst 12, Even if it is changing the exhaust air fuel ratio of the catalyst upstream, the exhaust air fuel ratio of the catalyst downstream is maintained by abbreviated theoretical air fuel ratio, and the downstream  $O_2$  sensor 15 output VOS is changed in between a rich side and the Lean sides a long cycle (refer to drawing 8 (A) VOS). In this state, it is drawing 8 (A). The locus length of the downstream  $O_2$  sensor 15 output VOS is comparatively small, and the area of the portion surrounded by the output VOS and reference voltage  $V_{R2}$  is comparatively large so that it may be shown.

[0042]When the catalyst 12 is in a non-active state, The exhaust air fuel ratio of the catalyst 12 downstream comes to repeat the same periodic change with exhaust air fuel ratio change of the upstream for the fall of  $O_2$  storage operation of the catalyst 12, The downstream  $O_2$  sensor 15 output VOS comes (refer to drawing 8 (B)) to repeat the same change as upstream  $O_2$  sensor 13 output VOM. In this state, it is drawing 8 (B).

The locus length of the downstream  $O_2$  sensor 15 output VOS becomes comparatively large, and the area of the portion surrounded by the output VOS and reference voltage  $V_{R2}$  becomes comparatively small so that it may be shown.

[0043]In this example, the control circuit 10 The ratio of locus length LVOS of the downstream  $O_2$  sensor 15 output VOS, and locus length LVOM of upstream  $O_2$  sensor 13 output VOM, LRATIO

(LRATIO=LVOS/LVOM) -- and, The area ARATIO (ARATIO=AVOS/AVOM) surrounded by the area AVOS and upstream  $O_2$  sensor 13 output VOM which are surrounded by the downstream  $O_2$  sensor 15 output VOS and reference voltage  $V_{R2}$ , and reference voltage  $V_{R1}$  is calculated, When LRATIO and ARATIO have a fixed relation, it is judged that the catalyst 12 is in a non-active state.

[0044]That is, the catalyst 12 will be from a non-active state in an active state, the locus length ratio LRATIO becomes small as the exhaust-air-purification capability of a catalyst increases, and the surface ratio ARATIO becomes large conversely. Then, in this example, when the relation between the locus length ratio LRATIO and the surface ratio ARATIO is in the field shown with the slash of drawing 9 using a judgment map as shown in drawing 9, it is judged that the catalyst 12 is in a non-active state.

[0045]The locus length ratio LRATIO which broke the locus length and area of the downstream  $O_2$  sensor 15 output VOS by this example in the locus length and area of upstream  $O_2$  sensor 13 output VOM, respectively. ARATIO is used in order to eliminate the influence by change of the engine air fuel ratio upset condition by operational status and to judge catalytic activation correctly. In the judgment map of drawing 9, when the locus length ratio LRATIO is below a predetermined value (K1), have judged with the catalyst

having been activated irrespective of the value of the surface ratio ARATIO, but. If the catalyst is being activated when the engine air fuel ratio is controlled by small amplitude focusing on theoretical air fuel ratio, this, It is because it has a possibility of producing incorrect judgment when the exhaust air fuel ratio of the catalyst downstream stops almost changing, been in agreement with theoretical air fuel ratio, and becomes very small [ AVOS and AVOM ] and activation is judged based on ARATIO.

[0046]Drawing 10 to drawing 13 is a flow chart which shows the routine of the above-mentioned catalytic activation judgment performed by the control circuit 10. This routine is performed 4 ms of fixed time, for example, every. it is judged [ drawing 10 and ] whether if it comes out and a routine starts, the conditions for a catalytic activation judging will be satisfied in Steps 1001-1004. Here, the conditions for a judgment are (1). The 1st Air Fuel Ratio Control by upstream  $O_2$  sensor 13 output is carried out, Namely, the thing for which the value of the flag XMFB (drawing 2, Steps 224 and 225) is set to 1 (Step 1001), (2) It is not detected that the output of the upstream  $O_2$  sensor 13 has stopped at the Lean side by RIN monitor beyond in predetermined time (Step 1002), (3) It is not detected that upstream  $O_2$  sensor 13 output has stopped at a rich side by rich monitor beyond in predetermined time (Step 1003), (4) The 2nd Air Fuel Ratio Control by downstream  $O_2$  sensor 15 output is carried out, That is, it is that the value of the flag XSFB (drawing 5, Steps 508 and 519) is set to 1 (Step 1004) etc., and only when all the above-mentioned conditions are satisfied, a 1005 or less-step catalytic activation judging is performed.

[0047]The above-mentioned conditions (2) Having provided (3), Even if it is [ feed-back-control-of-air-fuel-ratio ] under execution by upstream  $O_2$  sensor 13 output, it is because a value with the effective area AVOM may not be obtained if it is changing while upstream  $O_2$  sensor 13 output VOM had inclined toward the Lean and rich side. When all of the above-mentioned conditions are materialized, it progresses to drawing 11 and Step 1005, and the locus length LVOM and the area AVOM of upstream  $O_2$  sensor 13 output calculate a routine by the following formulas.

[0048]  
 $LVOM \leftarrow LVOM + |VOM - VOM_{i-1}|$   $AVOM \leftarrow AVOM + |VOM - V_{R1}|$  -- here,  $VOM_{i-1}$  shows the value of VOM at the time of routine execution last time. That is, in this example, from change of upstream  $O_2$  sensor 13 output VOM for every routine execution, as shown in drawing 13, the locus length LVOM and the area AVOM are approximately determined as an integral value. Drawing 13 shows the case where an actually more quite long sampling period is taken to change of a sensor output, for explanation. In order to calculate locus length and area correctly, it may be made to calculate locus length and area in consideration of the waveform (inclination) of an output locus.

[0049]Subsequently, in Step 1006, the locus length LVOS and the area AVOS of downstream  $O_2$  sensor 15 output calculate by the following formulas like the above.

At  $LVOS \leftarrow LVOS + |VOS - VOS_{i-1}|$   $AVOS \leftarrow AVOS + |VOS - V_{R2}|$  and Step 1007, the value of  $VOM_{i-1}$  and  $VOS_{i-1}$  is updated in preparation for next routine execution.

[0050]After the above-mentioned operation, while it progresses to drawing 12 and Step 1009 and a routine counts up the counter CTIME, at Step 1010, it is judged whether the value of CTIME exceeded

predetermined value  $C_0$ . Here, when  $C_0$  judges catalytic activation, it is the routine repeat frequency equivalent to the time which can obtain significant locus length and area. It is needed that it is more than several times of the richness of upstream  $O_2$  sensor 13 output and the number of times of reversal between Lean at least, and such an exact activation judging of this time is attained that this time is long.

[0051]When the above-mentioned time has passed at Step 1010, the locus length ratio LRATIO and the surface ratio ARATIO are calculated as  $LRATIO \leftarrow LVOS/LVOMARATIO \leftarrow AVOS/AVOM$  at Step 1011.

[0052]Subsequently, at Steps 1012-1014, it is judged whether the catalyst 12 is being activated from the relation shown in drawing 9 using the locus length ratio LRATIO and the surface ratio ARATIO which were calculated by the above. That is, at Step 1012, it is judged whether the locus length ratio LRATIO is more than predetermined value  $K1$  (refer to drawing 9), since it will be thought that the catalyst 12 is being activated if it is  $LRATIO < K1$ , it progresses to Step 1014 and the value of catalytic activity status-flags FACT is set as 1.

[0053]moreover -- progressing to Step 1012, if it is  $LRATIO \geq K1$  -- the ratio of the locus length ratio LRATIO and the surface ratio ARATIO -- it is judged whether the value of  $LRATIO/ARATIO$  is more than predetermined value  $K2$  (refer to drawing 9). If it is  $LRATIO/ARATIO < K2$ , if the relation between the locus length ratio LRATIO and the surface ratio ARATIO is not contained in the slash field of drawing 9, Since it will be thought that a catalyst is in a non-active state if the value of the flag FACT is set as 1 at Step 1014 like the above and it is in  $LRATIO/ARATIO \geq K2$ , i.e., the slash field of drawing 9, the value of the flag FACT is set as zero at Step 1013. Variables, such as CTIME, LVOM, AVOM, LVOS, AVOS,  $VOM_{i-1}$ , and  $VOS_{i-1}$ , are cleared at the after-end step 1015, and this routine ends the above-mentioned step.

[0054]\*\* Warming-up operation drawing 14 of the catalyst shows the flow chart of the catalyst warming-up operation based on the above-mentioned catalytic activation decision result. This routine is performed by the control circuit 10, for example at drawing 12 and an interval shorter than predetermined time  $C_0$  of Step 1010. In drawing 14, a start of a routine will judge whether the catalyst 12 is being activated from the value of the catalytic activation flag FACT at Step 1401.

[0055]When the catalyst 12 is in a non-active state ( $FACT=0$ ), while the angle of delay of the organization ignition timing (BTDC) AIG is carried out only the predetermined value  $A1$  at Step 1402, opening DISC of ISC valve 22 increases only the predetermined value  $A2$  at Step 1403. When the catalyst 12 is being activated at Step 1401 ( $FACT=1$ ), the tooth lead angle of the ignition timing AIG is carried out only  $A1$  at Steps 1404 and 1405, and opening DISC of ISC valve 22 decreases only by  $A2$ .

[0056]Subsequently, in Steps 1406-1409, the ignition timing AIG set up by the above is guarded by permission maximum angle-of-delay ignition-timing  $AIG_{MAX}$  and optimal-ignition-timing  $AIG_{OPT}$  of an organization. That is, the angle of delay of the ignition timing AIG is not carried out from  $AIG_{MAX}$ , and a tooth lead angle is not carried out from optimal-ignition-timing  $AIG_{OPT}$ . Here, optimal-ignition-timing  $AIG_{OPT}$  is a value set up by the routine (not shown) separately performed by the control circuit 10 according to engine operation conditions.

[0057]At Steps 1410-1413, ISC valve opening DISC is similarly guarded by allowable maximum opening  $DISC_{MAX}$  and optimal opening  $DISC_{OPT}$  set up according to operational status. Subsequently, at Step 1414, the Ignition timing AIG and ISC valve opening DISC which were set up by the above are stored in RAM105,

and a routine is ended.

[0058]When the catalyst 12 is in a non-active state, the specified quantity [ every ] angle of delay of the organization ignition timing is carried out for every routine execution by the above-mentioned routine execution, and by it, an ISC valve opening increases the specified quantity every. After the temperature of the catalyst 12 rises by this and the catalyst 12 is activated, ignition timing and an ISC valve opening, until the optimal ignition timing and the optimal opening according to an engine operation state are obtained -- every routine execution -- respectively -- a specified quantity [ every ] tooth lead angle -- and it will decrease, and after reaching optimal ignition timing and the optimal opening, it will be maintained by the state, respectively.

[0059]In this example, in order to avoid the abrupt change of ignition timing and an ISC valve opening, set it as the variation A1 and the quantity in which A2 is comparatively small, instead have set up the routine execution interval comparatively short (at for example, drawing 12 and an interval shorter than predetermined time  $C_0$  of Step 1010), but. It is also possible to set the variation A1 and A2 as a comparatively big quantity, and to set up the real line spacing of this routine comparatively long (at for example, interval longer than the above-mentioned  $C_0$ ).

[0060]As mentioned above, since opening increase of the angle of delay of ignition timing and an ISC valve is performed and the temperature of a catalyst continues rising when a catalyst is in a non-active state according to this example, even when activation temperature rises by degradation of a catalyst, it becomes possible to activate a catalyst certainly for a short time. Since the tooth lead angle of ignition timing and ISC valve opening reduction are conversely performed after a catalyst is activated, useless catalyst warming-up operation is prevented from catalyst warming-up operation always being performed in the necessary minimum range, and being performed.

[0061]When degradation of a catalyst advances substantially, the case where it stops demonstrating exhaust-air-purification capability with a sufficient catalyst also by catalyst warming-up operation can be considered. Although not shown in drawing 14, since it is coped with in such a case, it is also possible to generate an alarm signal, when the state (drawing 14 step 1407) where the angle of delay of the ignition timing was carried out to the maximum carries out fixed time continuation, and to report the abnormalities of a catalyst to a driver.

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[Translation done.]

## \* NOTICES \*

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2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

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## DESCRIPTION OF DRAWINGS

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### [Brief Description of the Drawings]

[Drawing 1] It is a schematic diagram showing one example of the internal-combustion engine which applied the exhaust emission control device of this invention.

[Drawing 2] It is a part of flow chart explaining Air Fuel Ratio Control of the internal-combustion engine of this example.

[Drawing 3] It is a part of flow chart explaining Air Fuel Ratio Control of the internal-combustion engine of this example.

[Drawing 4] They are drawing 2 and a timing diagram which gives prehension explanation of the flow chart of drawing 3.

[Drawing 5] It is a part of flow chart explaining Air Fuel Ratio Control of the internal-combustion engine of this example.

[Drawing 6] It is a part of flow chart explaining Air Fuel Ratio Control of the internal-combustion engine of this example.

[Drawing 7] It is a flow chart explaining fuel-oil-consumption operation operation of this example.

[Drawing 8] It is a timing diagram explaining the catalytic activation judging principle of this example.

[Drawing 9] It is a figure showing an example of the map for a catalytic activation judging.

[Drawing 10] It is a part of flow chart explaining catalytic activation determining operation.

[Drawing 11] It is a part of flow chart explaining catalytic activation determining operation.

[Drawing 12] It is a part of flow chart explaining catalytic activation determining operation.

[Drawing 13] It is a figure explaining the locus length and area of O<sub>2</sub> sensor output.

[Drawing 14] It is a flow chart explaining catalyst warming-up operation.

### [Description of Notations]

1 -- Main part of an organization

3 -- Air flow meter

10 -- Control circuit

12 -- Catalytic converter

13 -- Upstream O<sub>2</sub> sensor

15 -- Downstream O<sub>2</sub> sensor

22 -- ISC valve

\* NOTICES \*

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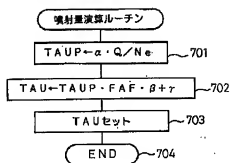
1. This document has been translated by computer. So the translation may not reflect the original precisely.
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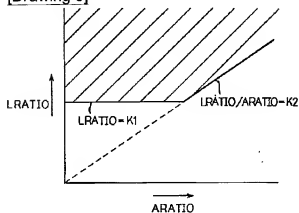
DRAWINGS

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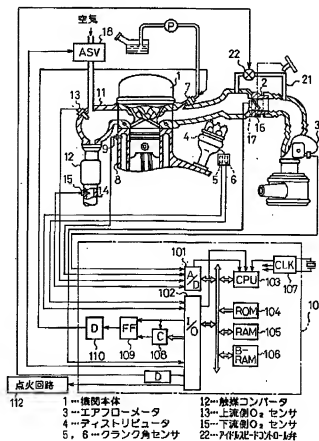
[Drawing 7]



[Drawing 9]

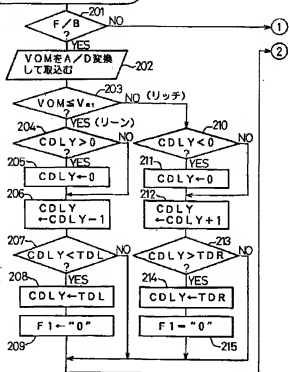


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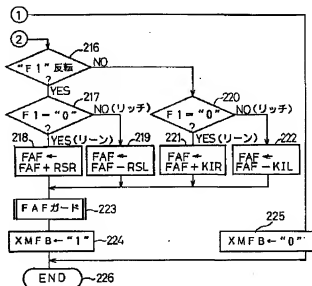


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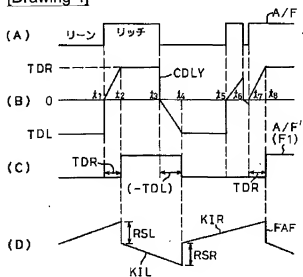
第1のA/Fフィードバック制御ルーチン



[Drawing 3]

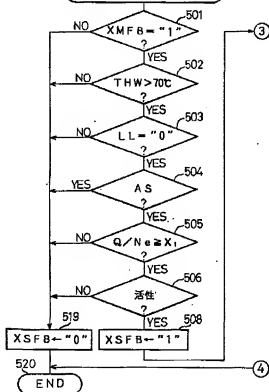


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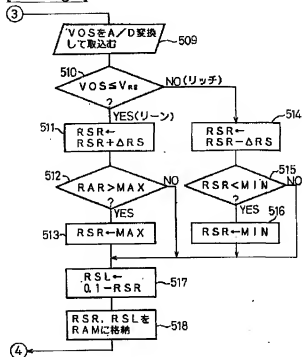


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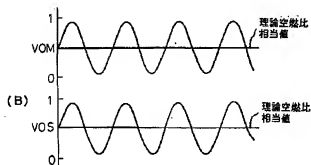
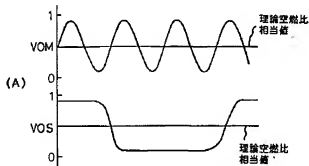
第2のA/Fフィードバック  
制御ルーチン



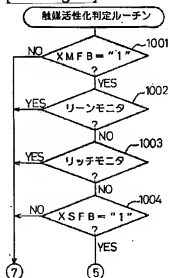
[Drawing 6]



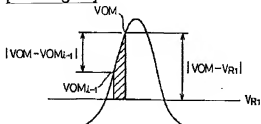
[Drawing 8]



[Drawing 10]



[Drawing 13]



[Drawing 11]

5

LVOM ← LVOM + |VOM - VOM<sub>i-1</sub>|  
AVOM ← AVOM + |VOM - V<sub>as</sub>|

LVOS ← LVOS + |VOS - VOS<sub>i-1</sub>|  
AVOS ← AVOS + |VOM - V<sub>as</sub>|

VOM<sub>i-1</sub> ← VOM, VOS<sub>i-1</sub> ← VOS

6

[Drawing 12]

6

CTIME ← CTIME + 1

CTIME > C<sub>s</sub>?

LRATIO, ARATIO 計算

LRATIO ≥ K<sub>1</sub>?

LRATIO ≥ K<sub>2</sub>?

FACT ← "0"

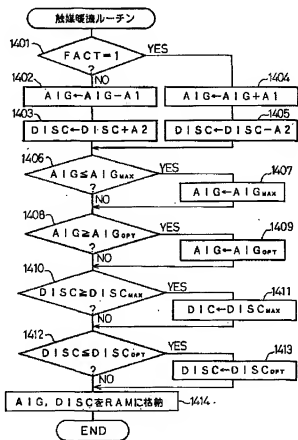
FACT ← "1"

CTIME, LVOM, AVOM, LVOS  
AVOS, VOM<sub>i-1</sub>, VOS<sub>i-1</sub>, クリア

7

END

[Drawing 14]



[Translation done.]

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(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平7-208153

(43) 公開日 平成7年(1995)8月8日

(51) Int. Cl. <sup>6</sup>	識別記号	序内整理番号	P I	技術表示箇所
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	3/24	Z A B R		
F 0 2 D	35/00	3 6 8 B		
	41/14	3 1 0 F		
		F 0 2 F 5/15		E
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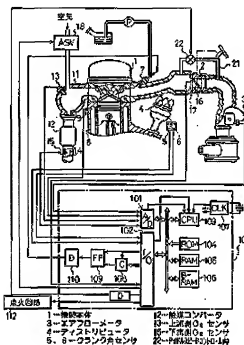
(74) 代理人 弁理士 石田 敏 (外3名)

(54) 【発明の名称】 内燃機関の排気浄化装置

(57) 【要約】

【目的】 触媒の劣化状態にかかわらず触媒暖機操作を適切に行う。

【構成】 触媒12の暖機操作を制御する制御回路10を設け、触媒上流側に設けたO<sub>2</sub>センサ13の出力と、下流側に設けたO<sub>2</sub>センサ15の出力とに基づいて触媒が活性化したか否かを判定するとともに、触媒非活性化時には機関1の点火時期遅延とアイドルスピード制御弁(ISC弁)22の開度増大を行い触媒の温度を上昇させる。触媒の活性化状態を直接検出して触媒暖機を行うため、触媒が短時間で確実に活性化するとともに、無駄な触媒暖機操作が防止される。



## 【特許請求の範囲】

【請求項1】 内燃機関の排気通路に設けられた三元触媒と、

該三元触媒の上流側排気通路に設けられ、三元触媒上流側の排気空燃比を検出する上流側空燃比センサと、

前記三元触媒の下流側排気通路に設けられ、三元触媒下流側の排気空燃比を検出する下流側空燃比センサと、

少なくとも前記上流側空燃比センサ出力に基づいて前記機関の空燃比を制御する空燃比制御手段と、

前記上流側空燃比センサ出力と前記下流側空燃比センサ出力とに基づいて前記三元触媒が非活性状態にあることを検出する触媒非活性状態検出手段と、

前記三元触媒の温度を上昇させる触媒昇温手段と、

前記三元触媒が非活性状態にあることが検出された時に、前記三元触媒昇温手段を制御して前記三元触媒の温度を上昇させる操作を行う触媒活性化手段と、を備えた内燃機関の排気浄化装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、内燃機関の排気浄化装置に関し、詳細には三元触媒の劣化の程度に応じて適切な触媒暖機操作を行うことが可能な排気浄化装置に関する。

【0002】

【従来の技術】内燃機関の排気通路に、排気中のHC、CO、NO<sub>x</sub>の3つの有害成分を同時に浄化可能な三元触媒を用いた触媒コンバータを配置した内燃機関の排気浄化装置が従来より広く用いられている。一般に、上記のような排気浄化装置に用いられる三元触媒はある温度（活性化温度）以上の温度にならないと排気浄化能力を発揮しない。このため、機関冷間始動時等に、例えば機関点火時期を遅角させる等の手段により触媒を通過する排気の温度を上昇させ、触媒温度を早期に活性化温度に到達させる、いわゆる触媒の暖機操作が行われる。

【0003】一方、触媒の活性化温度は常に一定ではなく、新しい触媒では活性化温度は比較的低く、触媒の劣化が進むにつれて活性化温度は上昇する傾向を示すため、上記触媒の暖機操作は触媒の劣化程度に応じて行う必要がある。例えば、特開昭60-153473号公報に

は、触媒温度を検出して、この触媒温度が予め定められた所定温度以下の場合には機関点火時期を遅角して触媒暖機操作を行うとともに、機関の累積運転時間の増加につれて上記所定温度を上昇させるようにした内燃機関の排気浄化装置が開示されている。

【0004】触媒の劣化程度は、使用時間、すなわち機関の累積運転時間が増加するにつれて進行すると考えられることから、触媒の活性化温度も機関累積運転時間が增大するにつれて高くなると考えられる。上記公報の装置では、前記所定温度を機関累積運転時間が増加するにつれて高くなるように予め設定しておき、実際に検出し

た触媒温度が上記所定温度以下の場合には触媒が活性化していないものとして点火時期遅角による触媒暖機を行い、触媒温度が上記所定温度以上になった時には触媒が活性化したものとして触媒暖機を停止するようにしたものである。

【0005】

【発明が解決しようとする課題】ところが、上記特開昭60-153473号公報の装置のように、触媒温度が機関の累積運転時間に基づいて決定される所定温度に到達したか否かのみによって触媒が活性化したか否かを判断していると現実には問題が生じる場合がある。すなわち、触媒の活性化温度は使用時間のみによって決定されるものではなく、機関の使用状態や気温等のばらつきにより触媒の劣化状態が変わってくるため、同一の使用時間（累積運転時間）であっても必ずしも触媒の活性化温度は一致しない場合がある。このため、上記公報の装置のように、触媒温度が所定温度に到達したか否かのみによって触媒の活性の有無を判断していると、実際には触媒が十分に活性化していないにもかかわらず触媒暖機操作が停止されてしまい、触媒の活性化が遅れて排気性状が悪化したり、或いは、実際には触媒が十分に活性化しているにもかかわらず点火時期遅角による触媒暖機操作が続けられるため、機関出力の低下や燃料消費増大等の問題が生じるのである。

【0006】この問題を解決するためには、触媒の活性の有無を触媒温度などを用いて間接的に検出するのではなく、直接的に触媒の活性化の有無を検出して、この検出結果に基づいて触媒の暖機操作を制御する必要がある。本発明は、上記に鑑み、触媒の活性化の有無を直接検出して触媒暖機操作を行うことが可能な内燃機関の排気浄化装置を提供することを目的としている。

【0007】

【課題を解決するための手段】本発明によれば、内燃機関の排気通路に設けられた三元触媒と、該三元触媒の上流側排気通路に設けられ、三元触媒上流側の排気空燃比を検出する上流側空燃比センサと、前記三元触媒の下流側排気通路に設けられ、三元触媒下流側の排気空燃比を検出する下流側空燃比センサと、少なくとも前記上流側空燃比センサ出力に基づいて前記機関の空燃比を制御する空燃比制御手段と、前記上流側空燃比センサ出力と前記下流側空燃比センサ出力とに基づいて前記三元触媒が非活性状態にあることを検出する触媒非活性状態検出手段と、前記三元触媒の温度を上昇させる触媒昇温手段と、前記三元触媒が非活性状態にあることが検出された時に、前記三元触媒昇温手段を制御して前記三元触媒の温度を上昇させる操作を行う触媒活性化手段と、を備えた内燃機関の排気浄化装置が提供される。

【0008】

【作用】触媒非活性状態検出手段は、上流側空燃比センサ出力と下流側空燃比センサ出力とに基づいて三元触媒

が非活性化状態であることを検出し、触媒活性化手段は触媒非活性化状態検出手段により、触媒が非活性化状態にあることが検出されたときにはのみ触媒の暖機を行う。このため、触媒温度にかかわらず、触媒が実際に活性化していない場合には暖機操作が実行され、触媒が実際に活性化している場合には暖機操作が停止されるので、触媒の劣化程度に応じて適切な暖機操作が行われる。

【0009】

【実施例】以下、添付図面を用いて本発明の実施例を説明する。図1は本発明の排気浄化装置を適用した内燃機関の全体概略図である。図1において、1は内燃機関本体、2は吸気通路、3は吸気通路に設けられたエアフロメータを示している。エアフロメータ3は吸入空気量を直接計測するものであって、たとえばポテンショメータを内蔵した可動ベーン式エアフロメータ等が使用され、吸入空気量に比例したアナログ電圧の出力信号を発生する。この出力信号は制御回路10のマルチプレクサ内蔵A/D変換器101に入力される。ディストリビュータ4には、その軸がたとえばクランク角に換算して72°毎に基準位置検出用パルス信号を発生するクランク角センサ5、およびクランク角に換算して30°毎にクランク角検出用パルス信号を発生するクランク角センサ6がそれぞれ設けられている。これらクランク角センサ5、6のパルス信号は制御回路10の入出力インターフェイス102に供給され、このうちクランク角センサ6の出力はCPU103の割込み端子に供給される。

【0010】さらに、吸気通路2には各気筒毎に燃料供給系から加圧燃料を吸気ポートへ供給するための燃料噴射弁7が設けられている。また、吸気通路2のスロットル弁16には、スロットル弁16が全開状態か否かを示す信号、すなわちLL信号を発生するアイドルスイッチ17が設けられている。このアイドル状態出力信号LLは制御回路10の入出力インターフェイス102に供給される。

【0011】本実施例では、吸気通路2にはスロットル弁16をバイパスするバイパス通路21と、このバイパス通路21を通過して流れる空気量を制御するアイドルスピードコントロール弁（ISC弁）22とが設けられている。ISC弁22はステッピングモータ等の適宜な形式のアクチュエータにより駆動される流量制御弁であり、制御回路10からの出力信号により作動し、アイドル時の機関吸入空気量を調節して機関のアイドル回転数を目指回転数に制御するのに用いられる。

【0012】本実施例では、ISC弁22は、後述のように触媒が活性化していない場合に機関アイドル回転数を上昇させることにより排気流量を増大させて触媒温度を上昇させる触媒昇温手段の一部として機能する。また、機関本体1のシリンダブロックのウォータージャケット8には、冷却水の温度を検出するための水温センサ9が設けられている。水温センサ9は冷却水の温度に応じ

たアナログ電圧の電気信号を発生する。この出力もA/D変換器101に供給されている。

【0013】機関1の排気マニホールド11より下流の排気系には、排気ガス中の3つの有害成分HC、CO、NO<sub>x</sub>を同時に浄化する三元触媒を収容する触媒コンバータ12が設けられている。また、触媒コンバータ12の上流側の排気マニホールド11、及び触媒コンバータ12の下流側の排気管14には、それぞれ上流側空燃比センサ（本実施例ではO<sub>2</sub>センサ）13と下流側空燃比センサ（本実施例ではO<sub>2</sub>センサ）15とが設けられている。

【0014】O<sub>2</sub>センサ13、15は、排気ガス中の酸素成分濃度を検出し、空燃比が理論空燃比に対してリーン側かリッチ側かに応じて異なる出力電圧を発生するものである。O<sub>2</sub>センサ13、15の出力電圧は、制御回路10のA/D変換器101に供給されている。図1に18で示したのは2次空気導入吸気弁であり、減速時あるいはアイドル時等に図示しないエアポンプ等の空気源から2次空気を排気マニホールド11に供給して、HC、COエミッションを低減するためのものである。

【0015】制御回路10は、たとえばマイクロコンピュータとして構成され、A/D変換器101、入出力インターフェイス102、CPU103の他に、ROM104、RAM105、バックアップRAM106、クロック発生回路107等が設けられている。本実施例では、制御回路10は、機関1の燃料噴射制御、点火時期制御等の基本制御を行う他、後述のように機関空燃比を制御する空燃比制御手段、触媒12が活性化状態にあるかを検出する触媒非活性化状態検出手段、機関点火時期の遅角とISC弁22とを制御して触媒暖機を行う触媒活性化手段等の請求項1に記載した各手段としての機能を果たしている。

【0016】さらに、制御回路10において、ダウンカウンタ108、フリップフロップ109、および駆動回路110は燃料噴射弁7を制御するためのものである。すなわち、後述のルーチンにおいて、燃料噴射時間（噴射時間）TAUが導き出されると、噴射時間TAUがダウンカウンタ108にプリセットされると共にフリップフロップ109がセットされる。この結果、駆動回路110が燃料噴射弁7の付勢を開始する。他方、ダウンカウンタ108がクロック信号（図示せず）を計数して最後にその出力端子が“1”レベルとなったときに、フリップフロップ109がセットされて駆動回路110は燃料噴射弁7の付勢を停止する。つまり、上述の燃料噴射時間TAUだけ燃料噴射弁7は付勢され、時間TAUに応じた量の燃料が機関1の燃焼室に供給されることになる。

【0017】また、制御回路10の入出力インターフェイス102は、点火回路112に接続されており、機関1の点火時期を制御している。すなわち、制御回路10は入出力インターフェイス102にクランク角センサ6

の基準クランク角パルス信号を入力後、クランク軸が所定の回転角度に達する毎に点火回路112に点火信号を出力し、各気筒の点火プラグ（図示せず）にスパークを発生させる。機関10の点火時期は、負荷（例えば機関10回転当たりの吸入空気量）、回転数等の運転条件の関数として制御回路10のROM104に最適値が格納されており、最適な点火時期が運転条件に応じて決定される。

【0018】エアフロメータ3の吸入空気量データおよび冷却水温データは所定時間もしくは所定クランク角毎に実行されるA/D変換ルーチンによって取込まれてRAM105の所定領域に格納される。つまり、RAM105における吸入空気量データおよび冷却水温データは所定時間毎に更新されている。また、回転速度データはクランク角センサ6の30°CA（クランク角）毎の割込みによって演算されてRAM105の所定領域に格納される。

【0019】本実施例では、制御回路10は上流側O<sub>2</sub>センサ13出力に基づいて機関空燃比を制御する第1の空燃比制御と、下流側O<sub>2</sub>センサ15出力に基づいて、この第1の空燃比制御を補正する第2の空燃比制御とを行う。以下、図2から図6を用いて制御回路10により実行される、この第1と第2の空燃比制御について説明する。

【0020】図2、図3は上流側O<sub>2</sub>センサ13の出力に基づいて空燃比補正係数FAFを演算する第1の空燃比フィードバック制御ルーチンを示している。本ルーチンは、所定時間たとえば4ms毎に実行される。ステップ201では、上流側O<sub>2</sub>センサ13による空燃比の開ループ（フィードバック）条件が成立しているか否かを判別する。たとえば、冷却水温が所定値（例えば70℃）以下の時、機関始動中、始動後増量中、暖機増量中、パワー増量中、触媒過熱防止のための燃料噴射量増量中、上流側O<sub>2</sub>センサ13の出力信号が一度も反転していない時、燃料カット中等はいずれも開ループ条件が不成立であり、その他の場合が開ループ条件成立である。開ループ条件が不成立のときは、図3、ステップ225に進み、空燃比フィードバックフラグXMBFを“0”とし、ステップ226に進みルーチンを終了する。なお、空燃比補正係数FAFを1.0としてもよい。他方、開ループ条件成立の場合はステップ202に進む。

【0021】ステップ202では、上流側O<sub>2</sub>センサ13の出力VOMをA/D変換して取込み、ステップ203にてVOMが比較電圧V<sub>1</sub>以下か否かにより、空燃比がリッチかリーンかを判別する。比較電圧V<sub>1</sub>は、通常O<sub>2</sub>センサ出力の振幅中心の電圧をとり、本実施例ではV<sub>1</sub>=0.45Vである。ステップ204から209、及びステップ210から215は、ステップ203で判定した上流側O<sub>2</sub>センサ13出力の値に基づく空燃比フラグF1の設定操作を示す。

【0022】空燃比フラグF1は、触媒12上流側の排気空燃比がリッチかリーンを示すフラグであり、フラグF1の値はディレイカウンタCDELAYのカウントダウン（リーン空燃比時）またはカウントアップ（リッチ空燃比時）操作により（ステップ206、212）上流側O<sub>2</sub>センサ13出力が所定の遅延時間（TDL、TDR）以上リッチまたはリーンに保持された場合1（リッチ）から0（リーン）、または0から1に変更される（ステップ207から209、ステップ213から215）。ここで、TDL（ステップ207、208）は上流側O<sub>2</sub>センサ13の出力がリッチからリーンに変化してもリッチ状態であるとの判断を保持するためのリーン遅延時間であって、負の値で定義され、TDR（ステップ213、214）は上流側O<sub>2</sub>センサ13の出力がリーンからリッチに変化してもリーン状態であるとの判断を保持するためのリッチ遅延時間であって、正の値で定義される。

【0023】次に、ステップ216では、空燃比フラグF1の符号が反転したか否か、すなわち遅延処理後の空燃比が反転したか否かを判別する。空燃比が反転していれば、ステップ217にて、空燃比フラグF1の値により、リッチからリーンへの反転か、リーンからリッチへの反転かを判別する。リッチからリーンへの反転であれば、ステップ218にて空燃比補正係数FAFをFAF-FAF+RSSRとスキップ的に増大させ、空燃比をリッチ側に補正する。また、逆にリーンからリッチへの反転であれば、ステップ219にて、FAF-FAF-RSSLとFAFをスキップ的に減少させて空燃比をリーン側に補正する。つまり、スキップ処理を行う。

【0024】ステップ216にて空燃比フラグF1の符号が反転していなければ、ステップ220、221、222にて積分処理を行う。つまり、ステップ220にて、F1=“1”か否かを判別し、F1=“0”（リーン）であればステップ221にてFAF-FAF+KILとし、他方、F1=“1”（リッチ）であればステップ222にてFAF-FAF-KILとする。ここで、積分定数KIL、KILはスキップ量RSSR、RSSLに比して十分小さく設定しており、KIL（KIL）<RSSR（RSSL）である。従って、ステップ221はリーン状態（F1=“0”）で空燃比を徐々にリッチ側に移行させ、ステップ222はリッチ状態（F1=“1”）で空燃比を徐々にリーン側に移行させる。

【0025】次に、ステップ223では、ステップ218、219、221、222にて演算された空燃比補正係数FAFは最小値たとえば0.8にてガードされ、また、最大値たとえば1.2にてガードされる。これにより、何らかの原因で空燃比補正係数FAFが大きくなり過ぎ、もしくは小さくなり過ぎた場合に、その値で機関の空燃比を制御してオーバーリッチ、オーバーリーンになるのを防ぐ。

【0026】ステップ224では、空燃比フィードバックフラグXMF Bを“1”とし、上述のごとく満算されたFAFをRAM105に格納して、ステップ226にてこのループは終了する。次に、本発明を上流側O<sub>2</sub>、センサ13の出力VOM及び下流側O<sub>2</sub>、センサ15の出力VOSの両方を用いて空燃比フィードバック制御を行うダブルO<sub>2</sub>センサシステムに適用した場合について説明する。

【0027】図4は図2、図3のフローチャートによる動作を補足説明するタイミング図である。上流側O<sub>2</sub>、センサ13の出力VOMにより図4(A)に示すごとくリッチ、リーン判別の空燃比信号A/Fが得られると、ディレイカウンタCDLYは、図4(B)に示すごとく、リッチ状態でカウントアップされ、リーン状態でカウントダウンされる。この結果、図4(C)に示すごとく、遅延処理された空燃比信号A/F'（フラグF1に相当）が形成される。たとえば、時刻t<sub>1</sub>にて空燃比信号A/F'がリーンからリッチに変化しても、遅延処理された空燃比信号A/F'はリッチ遅延時間TDRだけリッチに保持された後に時刻t<sub>2</sub>にてリッチに変化する。時刻t<sub>2</sub>にて空燃比信号A/F'がリッチからリーンに変化しても、遅延処理された空燃比信号A/F'はリーン遅延時間(-TDL)相当だけリッチに保持された後に時刻t<sub>3</sub>にてリーンに変化する。しかし空燃比信号A/F'が時刻t<sub>1</sub>、t<sub>2</sub>、t<sub>3</sub>のごとくリッチ遅延時間TDRより短い期間で反転すると、ディレイカウンタCDLYが最大値TDRに到達するのに時間を要し、この結果、時刻t<sub>2</sub>にて遅延処理後の空燃比信号A/F'が反転される。つまり、遅延処理後の空燃比信号A/F'は遅延処理前の空燃比信号A/Fに比べて安定となる。このように遅延処理後の安定した空燃比信号A/F'にもとづいて図4(D)に示す空燃比補正係数FAFが得られる。

【0028】次に、下流側O<sub>2</sub>、センサ15による第2の空燃比フィードバック制御について説明する。第2の空燃比フィードバック制御としては、第1の空燃比フィードバック制御数としてのスキップ量RSR、RSL、積分定数KIR、KIL、遅延時間TDR、TDL、もしくは上流側O<sub>2</sub>、センサ13の出力VOMの比較電圧V<sub>A</sub>を可変にするシステムと、第2の空燃比補正係数FAF<sub>2</sub>を導入するシステムとがある。

【0029】たとえば、リッチスキップ量RSRを大きくすると、制御空燃比をリッチ側に移行でき、また、リーンスキップ量RSLを小さくしても制御空燃比をリッチ側に移行でき、他方、リーンスキップ量RSLを大きくすると、制御空燃比をリーン側に移行でき、また、リッチスキップ量RSRを小さくしても制御空燃比をリーン側に移行できる。したがって、下流側O<sub>2</sub>、センサ15の出力に応じてリッチスキップ量RSRを補正することにより空燃比が制御できる。また、リッチ積分定数KIR

Rを大きくすると、制御空燃比をリッチ側に移行でき、また、リーン積分定数KILを小さくしても制御空燃比をリッチ側に移行でき、他方、リーン積分定数KILを大きくすると、制御空燃比をリーン側に移行でき、また、リッチ積分定数KIRを小さくしても制御空燃比をリーン側に移行できる。従って、下流側O<sub>2</sub>、センサ15の出力に応じてリッチ積分定数KIRおよびリーン積分定数KILを補正することにより空燃比を制御できる。リッチ遅延時間TDRを大きくもしくはリーン遅延時間(-TDL)を小さく設定すれば、制御空燃比はリッチ側に移行でき、逆に、リーン遅延時間(-TDL)を大きくもしくはリッチ遅延時間(TDR)を小さく設定すれば、制御空燃比はリーン側に移行できる。つまり、下流側O<sub>2</sub>、センサ15の出力VOSに応じて遅延時間TDR、TDLを補正することにより空燃比が制御できる。さらにまた、比較電圧V<sub>A</sub>を大きくすると制御空燃比をリッチ側に移行でき、また、比較電圧V<sub>A</sub>を小さくすると制御空燃比をリーン側に移行できる。従って、下流側O<sub>2</sub>、センサ15の出力VOSに応じて比較電圧V<sub>A</sub>を補正することにより空燃比が制御できる。

【0030】これらスキップ量、積分定数、遅延時間、比較電圧を下流側O<sub>2</sub>、センサによって可変とすることはそれぞれに要所がある。たとえば、遅延時間を可変とすることにより非常に微妙な空燃比の調整が可能であり、また、スキップ量を可変とすることにより遅延時間のよう空燃比のフィードバック周期を長くすることなくレスポンスの良い制御が可能である。従って、これら可変量は当然2つ以上組み合わせられて用いられ得る。

【0031】次に、空燃比フィードバック制御数としてのスキップ量を可変にしたダブルO<sub>2</sub>センサシステムについて説明する。図5、図6は下流側O<sub>2</sub>、センサ15の出力VOSにもとづく第2の空燃比フィードバック制御ルーチンであって、所定時間たとえば512ms毎に実行される。ステップ501〜508では、下流側O<sub>2</sub>、センサ15出力による閉ループ制御条件が成立しているか条件が否かを判別する。たとえば、上流側O<sub>2</sub>、センサ13による閉ループ条件の不成立（ステップ501）に加えて、冷却水温T<sub>HW</sub>が所定値（たとえば70℃）以下のとき（ステップ502）、スロット弁16が全開（L<sub>L</sub>="1"）のとき（ステップ503）、回転速度N<sub>e</sub>、車速、アイドルスイッチ17の信号L<sub>L</sub>、冷却水温T<sub>HW</sub>等にもとづいて2次空気を導入されているとき（ステップ504）、軽負荷のとき（機関1回転当たりの吸入空気量Q/N<sub>e</sub>が所定値X<sub>1</sub>より小さいとき）（ステップ505）、下流側O<sub>2</sub>、センサ15が活性化していないとき（ステップ506）、等閉ループ条件が不成立であり、その他の場合が閉ループ条件成立である。閉ループ条件不成立であれば、ステップ509に進み、空燃比フィードバックフラグXSF Bをリセットし（"0"）、閉ループ条件成立であればステップ508

に進み、空燃比フィードバックフラグXSFBBをセットする(“1”)。

【0032】ステップ509~518のフローについて説明する。ステップ509は、下流側O<sub>2</sub>センサ15の出力VOSをA/D変換して取り込み、ステップ510にてVOSが比較電圧V<sub>A2</sub>(たとえばV<sub>A2</sub>=0.55V)以下か否かを判断する。つまり、空燃比がリッチかリーンかを判断する。なお、比較電圧V<sub>A2</sub>は触媒コンバータ12の上流、下流で生ガスの影響による出力特性が異なることおよび劣化速度が異なること等を考慮して上流側O<sub>2</sub>センサ13の出力の比較電圧V<sub>A1</sub>より高く設定されているが、この設定は任意でもよい。この結果、VOS≦V<sub>A2</sub>(リーン)であればステップ511、512、513に進み、VOS>V<sub>A2</sub>(リッチ)であればステップ514、515、516に進む。すなわち、ステップ511では、RSR←RSR+ΔRS(ΔRSは一定値)とし、つまり、リッチスキップ量RSRを増大させて空燃比をリッチ側に移行させ、ステップ512、513では、RSRを最大値MAX(=0.075)にてガードし、他方、ステップ514にてRSR←RSR-ΔRSとし、つまり、リッチスキップ量RSRを減少させて空燃比をリーン側に移行させ、ステップ515、516にてRSRを最小値MIN(=0.025)にてガードする。なお、最小値MINは過渡追従性がこたえないレベルの値であり、また、最大値MAXは空燃比変動によりドライバビリティの悪化が発生しないレベルの値である。

【0033】ステップ517では、リーンスキップ量RSLを、 $RSL=0.1-RSR$ とする。つまり、 $RSR+RSL=0.1$ とする。ステップ518では、スキップ量RSR、RSLをRAM105に格納し、ステップ520に進みルーチンを終了する。

【0034】図7は噴射量清算ルーチンであって、所定クランク角たとえば360°毎に実行される。ステップ701では、RAM105より吸入空気量データQ及び回転速度データNを、読出して基本噴射量TAUP(TAUPは理論空燃比を得る噴射時間)を清算する。たとえば $TAUP=\alpha \cdot Q/N$ 。(αは定数)とする。ステップ702では、最終噴射量TAUを、 $TAU=TAUP \cdot FAF \cdot \beta + \gamma$ により清算する。なお、β、γは他の運転状態パラメータによって定まる補正量である。次いで、ステップ703にて、噴射量TAUをダウンカウンタ108にセットすると共にフリップフロップ109をセットして燃料噴射を開始させる。そして、ステップ704にてこのルーチンを終了する。

【0035】なお、上述のごとく、噴射量TAUに相当する時間が経過すると、ダウンカウンタ108の出力信号によってフリップフロップ109がリセットされて燃

料噴射は終了する。次に、本実施例の触媒暖機制御について説明する。本実施例では、制御回路10は後述するように上流側O<sub>2</sub>センサ13と下流側O<sub>2</sub>センサ15とに基づいて触媒12が活性化しているか(排気浄化能力を発揮しているか)否かを判断し、触媒12が非活性化状態にあると判断された場合には点火時期を遅らせるとともに、前述のISC弁22の開度を増加させる。

【0036】機関点火時期を遅らせることにより、各気筒での燃焼が排気行程近くで生じようになるため排気温度は上昇し、さらにISC弁22の開度を増加させることにより機関吸入空気量が增大し、排気ガス量が増大する。このため触媒12に流入する排気ガスの温度は上昇し、しかも排気ガス流量も増大するため触媒12の暖機が促進される。また、上記暖機操作により触媒12の温度が上昇して触媒12が活性化すると、制御回路10は機関点火時期を遅らせて最適点火時期に設定するとともに、ISC弁22の開度を運転状態により定まる最適開度に設定する。これにより、触媒12が活性化して正常な排気浄化作用が開始されると点火時期とISC弁22開度とは通常運転時の値に速やかに復帰することになる。

【0037】以下、本実施例の触媒暖機制御を、①触媒の活性化状態の判定動作、②触媒の暖機動作に分けて説明する。

【0038】①触媒活性化状態の判定動作

本実施例では、触媒12のO<sub>2</sub>ストレージ作用を利用して触媒12が活性化状態にあるか否かを判断する。すなわち、三元触媒は一般に排気空燃比がリーンのときに排気中の余剰酸素を吸着し、排気空燃比がリッチになると吸着した酸素を放出するO<sub>2</sub>ストレージ作用を行う。機関1がO<sub>2</sub>センサ13、15の出力に基づいて前述のようにフィードバック制御されていると、図4に示したように機関空燃比(FAF)はリッチ空燃比とリーンの空燃比との間で周期的に変動し、触媒に流入する排気空燃比もリッチ空燃比とリーン空燃比との間で周期的に変動することになる。触媒が活性化して正常に機能している場合には、上述のO<sub>2</sub>ストレージ作用により、流入する排気空燃比がリーン側に振れたときには排気中の余剰の酸素が触媒に吸着され、流入する排気空燃比がリッチ側に振れたときには吸着された酸素が排気に放出されるため、触媒を通過した排気空燃比変動は小さくなり、理論空燃比近傍に維持される。

【0039】しかし、触媒が非活性化状態にあり正常に機能していない場合には、触媒12のO<sub>2</sub>ストレージ作用が低下するため、触媒を通過した排気空燃比変動は大きくなり、触媒に流入する排気空燃比変動に伴って周期的に変動するようになる。従って、上流側O<sub>2</sub>センサ13出力と下流側O<sub>2</sub>センサ15出力とを比較することにより触媒12が活性化しているか否かを正確に検出することができる。

【0040】図8(A)(B)は空燃比フィードバック制御中の触媒12上流側のO<sub>2</sub>センサ13出力VOMと下流側のO<sub>2</sub>センサ15出力VOSの変化を示し、図8(A)は触媒12が活性化して正常に機能している場合を、図8(B)は触媒12が非活性化状態にある場合をそれぞれ示している。空燃比フィードバック制御中は、図4に示したように、機関空燃比はリッチ空燃比とリーン空燃比との間で周期的に変動を繰り返すため、上流側O<sub>2</sub>センサ13出力VOMもリッチ空燃比相当出力(例えば0.9ボルト)とリーン空燃比相当出力(例えば0.1ボルト)との間で周期的な変動を繰り返すことになる(図8(A)(B) VOM参照)。

【0041】一方、触媒12が活性化状態にあって正常に機能している場合には、触媒を通過した排気空燃比変動は触媒12のO<sub>2</sub>ストレージ作用により緩和されるため、触媒上流側の排気空燃比が変動していても触媒下流側の排気空燃比は理論空燃比に維持され、下流側O<sub>2</sub>センサ15出力VOSは長い周期でリッチ側とリーン側との間を変動する(図8(A) VOS参照)。この状態では、図8(A)に示すように、下流側O<sub>2</sub>センサ15出力VOSの軌跡長さは比較的小さく、また、出力VOSと基準電圧V<sub>ss</sub>とで囲まれる部分の面積は比較的大きい。

【0042】また、触媒12が非活性化状態にある場合には、触媒12のO<sub>2</sub>ストレージ作用の低下のため、触媒12下流側の排気空燃比は上流側の排気空燃比変動に伴って同様な周期的変動を繰り返すようになる(図8(B)参照)。この状態では、図8(B)に示すように、下流側O<sub>2</sub>センサ15出力VOSの軌跡長さは比較的大きくなり、出力VOSと基準電圧V<sub>ss</sub>とで囲まれる部分の面積は比較的小さくなる。

【0043】本実施例では、制御回路10は、下流側O<sub>2</sub>センサ15出力VOSの軌跡長さLVOSと上流側O<sub>2</sub>センサ13出力VOMの軌跡長さLVOMとの比、L RATIO (L RATIO = LVOS / LVOM) 及び、下流側O<sub>2</sub>センサ15出力VOSと基準電圧V<sub>ss</sub>とで囲まれる面積AVOSと上流側O<sub>2</sub>センサ13出力VOMと基準電圧V<sub>ss</sub>とで囲まれる面積ARATIO (ARATIO = AVOS / AVOM) とを計算し、L RATIO とARATIO とが一定の関係にあるときに触媒12が非活性化状態であると判断する。

【0044】すなわち、触媒12が非活性化状態から活性化状態になり、触媒の排気浄化能力が増大するにつれて軌跡長さL RATIO は小さくなり、逆に面積比ARATIO は大きくなる。そこで、本実施例では、図9に示すような判定マップを用いて、軌跡長さL RATIO と面積比ARATIO との関係が図9の斜線で示した領域に\*

ある場合には、触媒12が非活性化状態にあると判断している。

【0045】なお、本実施例で下流側O<sub>2</sub>センサ15出力VOSの軌跡長と面積とをそれぞれ上流側O<sub>2</sub>センサ13出力VOMの軌跡長と面積とで割った軌跡長さL RATIO、ARATIOを用いているのは、運転状態による機関空燃比変動状態の変化による影響を排除して正確に触媒活性化の判断を行うためである。また、図9の判定マップでは、軌跡長さL RATIO が所定値<K

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1) 以下の場合には面積比ARATIOの値にかかわらず触媒が活性化したと判定しているが、これは機関空燃比が理論空燃比を中心として小さな振幅で制御されているような場合、触媒が活性化していると、触媒下流側の排気空燃比は理論空燃比に一致したままで変動しなくなり、AVOS、AVOMともに極めて小さくなり、ARATIOに基づいて活性化の判断を行うと誤判断を生じる恐れがあるためである。

【0046】図10から図13は制御回路10により実行される上記触媒活性化判断のルーチンを示すフローチャートである。本ルーチンは、一定時間、例えば4ms毎に実行される。図10、でルーチンがスタートすると、ステップ1001から1004では、触媒活性化判定のための条件が成立しているか否かが判断される。ここで、判定のための条件は、(1) 上流側O<sub>2</sub>センサ13出力による第1の空燃比制御が実施されていること、すなわちフラグX MFB (図2、ステップ224、225)の値が1にセットされていること(ステップ1001)、(2) リーンモニタにより上流側O<sub>2</sub>センサ13の出力が所定時間以上リーン側に留まっていることが検出されていないこと(ステップ1002)、(3) リッチモニタにより上流側O<sub>2</sub>センサ13出力が所定時間以上リッチ側に留まっていることが検出されていないこと(ステップ1003)、(4) 下流側O<sub>2</sub>センサ15出力による第2の空燃比制御が実施されていること、すなわちフラグX SFB (図5、ステップ508、519)の値が1にセットされていること(ステップ1004)、等であり、上記条件の全てが成立した場合にのみステップ1005以下の触媒活性化判定が実行される。

【0047】なお、上記条件(2)(3)を設けたのは、上流側O<sub>2</sub>センサ13出力による空燃比フィードバック制御実行中であっても、上流側O<sub>2</sub>センサ13出力VOMがリーン側かリッチ側かに偏ったまま変動していると面積AVOMの有効な値が得られない場合があるためである。上記条件の全てが成立した場合には、ルーチンは図11、ステップ1005に進み、上流側O<sub>2</sub>センサ13出力の軌跡長さLVOMと面積AVOMとが、以下の式により演算される。

【0048】

$$LVOM \leftarrow LVOM + |VOM - VOM_{1,1}|$$

$$AVOM \leftarrow AVOM + |VOM - V_{ss}|$$

ここで、 $VOM_{i-1}$  は前回ルーチン実行時のVOMの値を示している。すなわち、本実施例では、ルーチン実行毎の上流側 $O_2$  センサ13出力VOMの変化から、図13に示すように軌跡長LVOMと面積AVOMを近似的に積分値として求めている。なお、図13では説明のため、センサ出力の変化に対してサンプリング間隔を實際よりかなり長く取った場合を示している。また、さらに本

$$\begin{aligned} LVOS &\leftarrow LVOS + |VOS - VOS_{i-1}| \\ AVOS &\leftarrow AVOS + |VOS - V_{s,i}| \end{aligned}$$

また、ステップ1007では今回のルーチン実行に備えて $VOM_{i-1}$  と $VOS_{i-1}$  の値が更新される。

【0050】上記の演算の後、ルーチンは図12、ステップ1009に進みカウンタCTIMEをカウントアップするとともに、ステップ1010ではCTIMEの値が所定値C<sub>0</sub>を越えたか否かが判定される。ここで、C<sub>0</sub>は、触媒活性化を判断する上で有意義な軌跡長、面積を得ることが出来る時間に相当するルーチン繰り返し回数である。この時間は少なくとも上流側 $O_2$  センサ13出力のリッチ、リーン間の反転回数の数回分以上であることが必要とされ、この時間が長い程正確な活性化判定が可能となる。

【0051】ステップ1010で上記時間が経過している場合は、ステップ1011で、軌跡長比LRATIOと面積比ARATIOとが、 $LRATIO \leftarrow LVOS/LVOM$   
 $ARATIO \leftarrow AVOS/AVOM$ として計算される。

【0052】次いで、ステップ1012から1014では上記により計算した軌跡長比LRATIOと面積比ARATIOとを用いて、図9に示した関係から触媒12が活性化しているか否かが判定される。すなわち、ステップ1012では軌跡長比LRATIOが所定値K1（図9参照）以上か否かが判定され、LRATIO < K1であれば触媒12が活性化していると考えられるため、ステップ1014に進み、触媒活性化状態フラグFACTの値を1に設定する。

【0053】また、LRATIO ≥ K1であればステップ1012に進み、更に軌跡長比LRATIOと面積比ARATIOとの比LRATIO/ARATIOの値が所定値K2（図9参照）以上か否かを判断する。LRATIO/ARATIO < K2であれば、すなわち軌跡長比LRATIOと面積比ARATIOとの関係が、図9の斜線領域に入っていないければ、上記と同様ステップ1014でフラグFACTの値が1に設定され、LRATIO/ARATIO ≥ K2。すなわち図9の斜線領域にあれば、触媒が非活性化状態にあると考えられるため、ステップ1013でフラグFACTの値はゼロに設定される。また上記ステップを終了後ステップ1015でCTIME、LVOM、AVOM、LVOS、AVOS、VOM<sub>i-1</sub>、VOS<sub>i-1</sub>等の変数がクリアされ本ルーチン

\* 正確に軌跡長と面積とを計算するために出力軌跡の波形（傾き）を考慮して軌跡長と面積とを計算するようにしてもよい。

【0049】次いで、ステップ1006では、上記と同様に下流側 $O_2$  センサ15出力の軌跡長LVOSと面積AVOSとが以下の式により演算される。

$$\begin{aligned} LVOS &\leftarrow LVOS + |VOS - VOS_{i-1}| \\ AVOS &\leftarrow AVOS + |VOS - V_{s,i}| \end{aligned}$$

10 は終了する。

#### 【0054】触媒の暖機動作

図14は、上記触媒活性化判定結果に基づき触媒暖機動作のフローチャートを示している。本ルーチンは制御回路10により、例えば図12、ステップ1010の所定時間C<sub>0</sub>より短い間隔で実行される。図14において、ルーチンがスタートするとステップ1401では、触媒活性化フラグFACTの値から触媒12が活性化しているか否かが判定される。

【0055】触媒12が非活性化状態にある場合（FACT = 0）には、ステップ1402で機関点火時期（BTDC）AIGが所定値A1だけ進角されるとともに、ステップ1403でISC弁22の開度DISCが所定値A2だけ増大される。また、ステップ1404で触媒12が活性化している場合（FACT = 1）には、ステップ1404、1405で点火時期AIGがA1だけ進角され、ISC弁22の開度DISCはA2だけ減少される。

【0056】次いでステップ1406から1409では、上記により設定された点火時期AIGは機関の許容最大進角点火時期AIG<sub>max</sub>と最速点火時期AIG<sub>opt</sub>とでガードされる。すなわち、点火時期AIGはAIG<sub>max</sub>より進角されることはなく、最速点火時期AIG<sub>opt</sub>より進角されることはない。ここで、最速点火時期AIG<sub>opt</sub>は別途制御回路10により実行されるルーチン（図示せず）により、機関運転条件に応じて設定される値である。

【0057】また、ステップ1410から1413では同様に、ISC弁開度DISCが許容最大開度DISC<sub>max</sub>と、運転状態に応じて設定される最適開度DISC<sub>opt</sub>とによりガードされる。次いで、ステップ1414では上記により設定された点火時期AIGとISC弁開度DISCとをRAM105に格納しルーチンを終了する。

【0058】上記ルーチン実行により、触媒12が非活性化状態にある場合には機関点火時期はルーチン実行毎に所定量ずつ進角され、ISC弁開度は所定量ずつ増大される。また、これにより触媒12の温度が上昇して触媒12が活性化した後には点火時期とISC弁開度とは、機関運転状態に応じた最速点火時期と最適開度とが得られるまでルーチン実行毎にそれぞれ所定量ずつ進角及び減

少され、最適点火時期と最適開度とに到達後はそれぞれその状態に維持されることになる。

【0059】なお、本実施例では点火時期とISC弁開度との急激な変化を避けるために変化量A1、A2は比較的小さい量に設定して、その代わりにルーチン実行間隔を比較的小さい（例えば図12、ステップ1010の所定時間C、より短い間隔に）設定しているが、変化量A1、A2を比較的大きな量に設定して本ルーチンの実行間隔を比較的大きく（例えば上記C、より長い間隔に）設定することも可能である。

【0060】上述のように、本実施例によれば触媒が非活性状態にある場合には点火時期の遅角とISC弁の開度増大とが行われて触媒の温度が上昇し続けるため、触媒の劣化により活性化温度が上昇したような場合でも短時間で確実に触媒を活性化させることが可能となる。また、触媒が活性化した後には逆に点火時期の遅角とISC弁開度減少とが行われるため、触媒暖機操作は常に必要最小限の範囲で実行されることになり無駄な触媒暖機操作が行われることが防止される。

【0061】なお、触媒の劣化が大幅に進行した場合には触媒暖機操作によっても触媒が十分な排気浄化能力を発揮しなくなる場合が考えられる。図14には示していないが、このような場合に対処するため、点火時期が最大限に遅角された状態（図14ステップ1407）が一定時間継続したときに警報信号を発生して、運転者に触媒の異常を報知するようにすることも可能である。

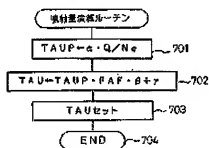
【0062】

【発明の効果】本発明は、上述のように触媒の活性化の有無を直接検出して、触媒が非活性状態にあるときにのみ触媒暖機操作を行うようにしたことにより、触媒の劣化状態にかかわらず確実に触媒を短時間で活性化させることができるとともに、無駄な触媒暖機操作が行われることを防止できる効果を奏する。

【図面の簡単な説明】

【図1】本発明の排気浄化装置を適用した内燃機関の一\*

【図7】



\* 実施例を示す概略図である。

【図2】本実施例の内燃機関の空燃比制御を説明するフローチャートの一部である。

【図3】本実施例の内燃機関の空燃比制御を説明するフローチャートの一部である。

【図4】図2、図3のフローチャートを補足説明するタイミング図である。

【図5】本実施例の内燃機関の空燃比制御を説明するフローチャートの一部である。

10 【図6】本実施例の内燃機関の空燃比制御を説明するフローチャートの一部である。

【図7】本実施例の燃料噴射量演算動作を説明するフローチャートである。

【図8】本実施例の触媒活性化判定原理を説明するタイミング図である。

【図9】触媒活性化判定用のマップの一例を示す図である。

【図10】触媒活性化判定動作を説明するフローチャートの一部である。

20 【図11】触媒活性化判定動作を説明するフローチャートの一部である。

【図12】触媒活性化判定動作を説明するフローチャートの一部である。

【図13】O<sub>2</sub> センサ出力の軌跡長と面積とを説明する図である。

【図14】触媒暖機動作を説明するフローチャートである。

【符号の説明】

1…機関本体

30 3…エアフローメータ

10…制御回路

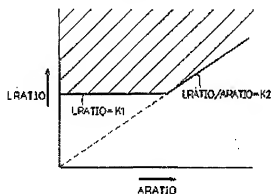
12…触媒コンバータ

13…上流側O<sub>2</sub> センサ

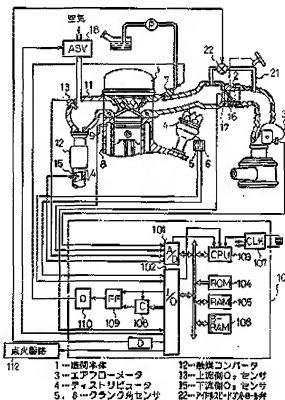
15…下流側O<sub>2</sub> センサ

22…ISC弁

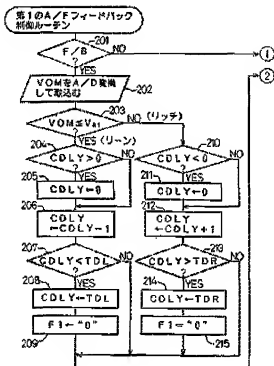
【図9】



【図1】

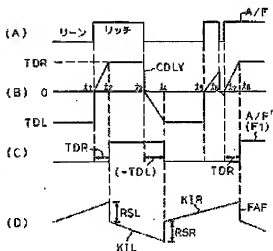
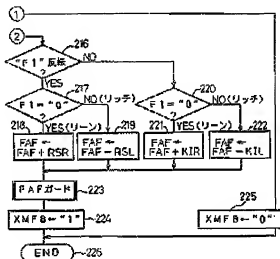


【図2】

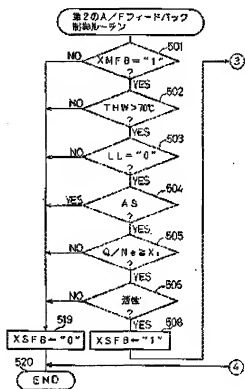


【図4】

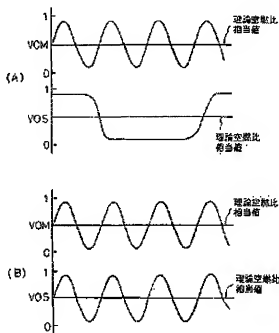
【図3】



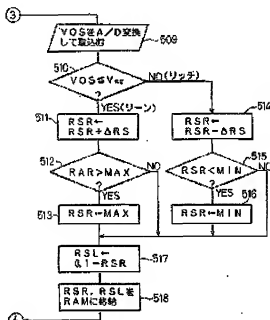
【図5】



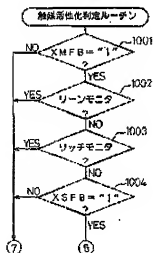
【図8】



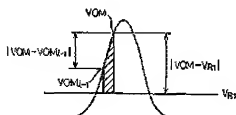
【図6】



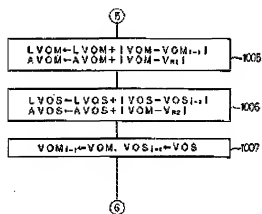
【図10】



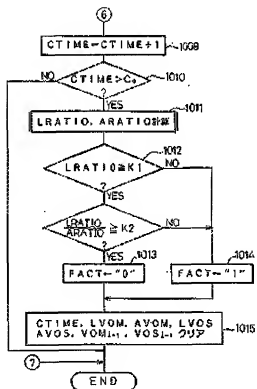
【図13】



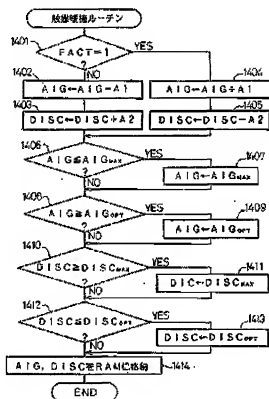
【図11】



【図12】



【図14】



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